RAILROAD GAZETTE

FRIDAY, JUNE 20, 1902.

CONTENTS

Contributions

On the Cause of Foaming in Locomotive Boilers.

126 Liberty St., New York, June 16, 1902.

TO THE EDITOR OF THE RAILROAD GAZETTE:

We are much gratified to read in the *Railroad Gazette* of June 13, 1902, under the above caption, the able and comprehensive communication from Mr. C. Herschel Koyl regarding the cessation of foaming in the locomotives of the Rio Grande Western Railway, due to their exclusive use of treated water. This is especially pleasing to us because of the present disinterestedness of the writer of that letter in the company which designed and built the apparatus. To his lucid disquisition the only annotation we wish to make is to call attention to the fact that wherever in his article mention is made of "my water-softening-and-clarifying-machine," "my machine," etc., etc., the writer refers, in each case, to machines installed by the Industrial Water Company.

INDUSTRIAL WATER COMPANY.

[We suppose that it is true that Mr. Koyl, more than any other one man, is the designer of the apparatus and methods of the Industrial Water Company. He took up and forwarded to practical usefulness certain valuable but crude patents. No doubt he used the expressions quoted above with this fact lurking in the back of his brain, and without any very specific purpose.—EDITOR.]

The Zinc-Creosoting Process in the United States.

Chicago, June 11, 1902.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Having become impressed with the merits of the zinc-creosote process during my visit to Germany, where it is said to impart, when well done, an average life of 15 to 18 years to beech and to pine railroad ties, I determined to test it in the United States, in order to learn whether good work could be done with the information obtained. There were difficulties in the way. The first was that the German specifications require a peculiar tar-oil, with a high boiling point and rich in tar-acids, and that this is not produced in this country. After a year spent in inquiries here, suitable tar-oil had to be imported from abroad. The second difficulty was to obtain an intimate mixture or emulsion between the tar-oil and a solution of chloride of zinc, but this was obtained after a few trials.

Finally, during May, 1902, the Chicago Tie Preserving Company treated some 15,000 ties with zinc-creosote at its Mt. Vernon, Ill., plant, for the Chicago & Eastern Illinois Railroad. These were of red, black and water oak, while such other varieties of wood as could readily be procured were also experimented with. The work was purely experimental, and the increased cost was defrayed by the Tie Preserving Company.

The results were gratifying. The mixture was found to be very close, and to separate very slowly. It was injected into the ties to the extent of ½ lb. of zinc-chloride (dry salt) and 1 ¹/₁₀ lbs. of tar-oil per cubic foot, which is the German practice. Upon selecting specimen ties and sawing them across they were found thoroughly well treated at the ends and fairly well impregnated to the very center, showing that the tar-oil found its way into the wood quite as well as the zinc-chloride. It was found that white and yellow oak did not take the treatment nearly so well as black or red oak, but that sycamore was injected completely. Sections from the middle of these ties have been sent to the Shaw School of Botany at St. Louis, to be placed in its fungus pit, and the 15,000 experimental ties are being laid in the tracks of the C. & E. I. R. R. at various points. It is expected that they will show an average life of 14 to 16 years, or some two or three years more than the Wellhouse process. If so, zinc creosote will pay. It costs about six cents more per tie than Burnettizing, but a tie is worth some five cents a year in the track. The work, however, must be well done, as some zinc-creosoted ties have failed in Germany.

O. CHANUTE.

A Historical Drawing.

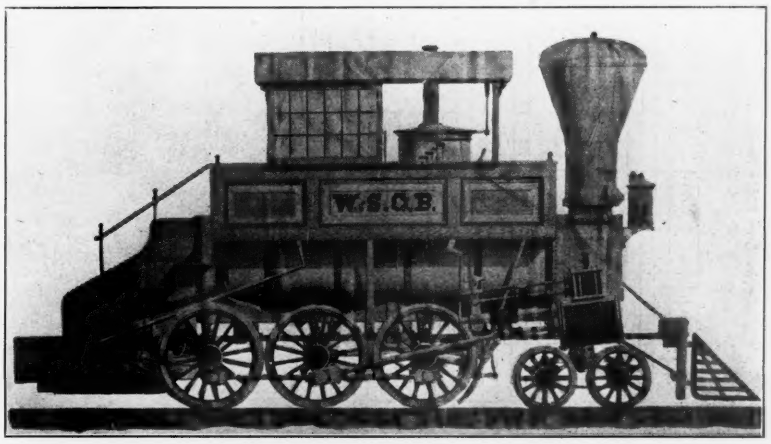
Purdue University, La Fayette, Ind., May 18, 1902.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In a communication which appeared in your issue of February 14th, I made reference to a drawing of a Hayes 10-wheel camel locomotive, which drawing I believe to be well worth reproduction and a brief description. The drawing was made by Mr. W. S. G. Baker, now President of the Baltimore Car Wheel Company, when an apprentice with the Baltimore & Ohio Railroad 49 years ago. It is Mr. Baker's belief that it represents the group of engines one of which has been recently sent to Purdue as a historic relic, by the Baltimore & Ohio Railroad Company. It is outlined in ink and is tinted in colors. The headlight bears a portrait of George Washington, cut from a green postage stamp and pasted in place. As received, the drawing was mounted on heavy paper and cut through to the form of the outline. It had been folded and bore evidence of neglect. Since its receipt, it has been mounted upon heavy bristol board and framed for preservation, thus constituting a most interesting relic. The copy which I send is a photograph of the restored drawing.

I need not add that in sending this drawing to Purdue, Mr. Baker has rendered important service to the University and to all who are interested in the historic development of the American locomotive.

W. F. M. GOSS.



The Hayes Ten-Wheelers.

The Heat Treatment of Cast Steel.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The instructive article by Mr. C. H. on "Microstructure and Metallurgy of Steel" (*Railroad Gazette*, June 13, p. 438) is a step in the right direction; but Fig. 4 should be reproduced on a much larger scale, with the dimensions of the bent pieces, chemical composition and method of manufacture, and in addition a photograph of the fracture on a large scale, on each bent piece (either bent as shown, or nicked and broken in order that we can tie up the structures with which we are familiar, as seen by the eye, with the microstructures. This is really the A B C of the whole business, but has been sadly neglected. The microstructures of Fig. 4 are so indistinct as to be of no particular value, whereas those in Figs. 1, 2 and 3 are very instructive. Is it fair to assume that Fig. 1 is a reproduction of test No. 1 in Fig. 4, No. 2 a reproduction of test No. 7, in Fig. 4, and Fig. 3, a reproduction of piece 10 in Fig. 4? If so, why not give the others on the same scale as the story would be most interesting? [References are to engravings not reprinted now. We wait for a photograph on a large scale.—EDITOR.]

I do not think I am asking too much to have Fig. 4 reproduced on a larger scale, with the other information referred to, as out of the 10 bent pieces, only one gives satisfactory results. It is this particular piece, No. 7, that should be made an object lesson to the users of steel castings, in order that they may insist on the castings being *annealed at the proper temperature* before they are put in service. Many of the manufacturers of steel castings claim that it is not necessary to anneal them, and to confirm their statements, produce such tests as shown by nine out of the 10 pieces shown on Fig. 4, which were the results of *annealing at improper temperatures, or not annealing at all.*

I call particular attention to this as in a recent paper read before the A. I. M. E. at the May meeting, I stated:

"We have just passed through a period in which the chemical composition of the steel has been given the greatest prominence, but failures of steel forgings and steel castings of the best chemical composition showed that you could not control the quality of the finished product by the chemical composition alone. It was shown that the great differences in the physical properties of the steel were produced by its heat treatment—either in connection with the mechanical work of forging or without. These changes are much greater than the changes produced by small differences in chemical composition. The result of all this is, that to-day there is a strong tendency to give the heat-treatment more importance than the chemical composition. I think the mean course is the safer, and give each an equal importance, for we know that to produce the best results we must start with a good uniform steel, using the best methods of manufacture and subsequent working, with intelligent supervision.

"Annealing of forgings and castings is much neglected. The manufacturers who are doing the highest class of work for our Government and others under rigid specifications, claim all such work should be annealed. Other manufacturers of a cheaper class of work claim that annealing is not necessary, even in some cases go so far as to claim that it is injurious. They give results to prove their assertions. It is only necessary to repeat the annealing under the proper conditions to prove the trouble was in the method of annealing used. In many cases attempts are made to anneal forgings that have been finished at too high a temperature, without first allowing them to cool down below the critical point. This is merely slow cooling and makes the material much worse than it would be if allowed to cool in the air.

"In consideration of above I would therefore suggest the discussion be directed towards the heat treatment of steel with an endeavor to decide some of the disputed points on their merits and thus improve the methods of manufacture."

These statements are fully confirmed by the results shown on Fig. 4 of the article referred to.

WILLIAM R. WEBSTER.

Tractive Power of Locomotives.

Purdue University, Lafayette, Ind., April 23, 1902.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In your issue of March 7, Professor Edward C. Schmidt presents evidence which appears to disprove the value of a certain equation which was proposed in a paper presented by me before the New England Railroad Club in December. The equation* in question is designed to give the maximum tractive force which, under favorable conditions, can be continuously exerted by a modern locomotive. A fact which is given all possible emphasis in that paper, and to which I again direct attention, is that the equation is designed to give *maximum* values. The full significance of this statement is evidently not appreciated by Professor Schmidt. He has drawn certain results from the records of a dynamometer-car obtained in connection with four different locomotives, has compared these results with those given by my equation, and announces as the result of his labor that, "for these four engines, the formula gives values for drawbar pull which are in general from 20 per cent. to 50 per cent. too great." This makes it clear that either my work is very wide of the mark or the standard by which Professor Schmidt has chosen to judge its value is at fault. A brief review of Professor Schmidt's data will, therefore, not be out of place.

First of all, attention should be directed to the wide variation in individual values. Professor Schmidt's data for three of the four engines tested disclose a wider variation between individual values than appears between their

$$^{*}\ t = 161\frac{H}{S} - 3.8\frac{d^2 L}{D} - W\left(2 + \frac{S}{6}\right) - 0.11 S^2$$

in which,
t = available pull at the drawbar of tender.
H = square feet of heating surface in boiler.
S = speed in miles per hour.
d = diameter of piston in inches.
L = length of stroke in feet.
D = diameter of drivers in feet.
W = tons weight of rolling load, including that on truck and tender but excluding that on drivers.

No value of t should be greater than ¼ weight on drivers.

mean value and the curve of my equation. Obviously not all of these points can correctly represent conditions of maximum power. Looking farther, there appears to be ground for question as to whether any of them represent maximum power. Upon this point Professor Schmidt makes three statements, namely, that the values given represent conditions of uniform speed and pull, that the engines were pulling their full tonnage rating, and that the throttle was wide open. But these statements are not sufficient. There are stretches of road where the full tonnage rating is a light load, and a wide open throttle may mean little or much, depending on the position of the reverse lever. Evidence of maximum power is to be found in heavy firing and in an adjustment of throttle and reverse lever which will serve to use every ounce of steam which the boiler can generate. I assume that such conditions did not prevail at the time Professor Schmidt's data were secured and hence I conclude that there is no necessary relation between his values and those given by my equation. His points are interesting as showing what certain engines *are doing;* my equation shows what they *may do.* His failure, therefore, to check my equation in no way discredits my work.

To the foregoing rejoinder I would add the following: In a paper on "Locomotive Rating" before the December meeting of the Western Railway Club, Mr. D. F. Crawford presents a diagram showing the relation of draw-bar pull to speed for Pennsylvania engine No. 413. The character of the data is similar to that presented by Professor Schmidt, except that they were obtained when the engine was under test for maximum power. The results

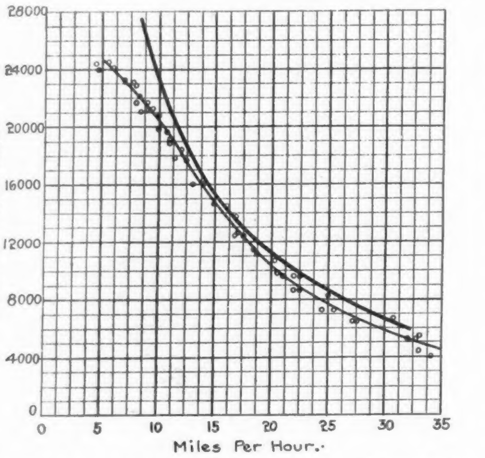


Diagram from Mr. D. F. Crawford on "Locomotive Rating."

are, therefore, comparable with those given by my equation. I have obtained from Mr. Crawford the constants for the engine and have taken the liberty to plot on his diagram the curve given by my equation, all with the result here presented. The points and light-lined curve are Mr. Crawford's and the heavy-lined curve is that obtained by use of my equation. While Mr. Crawford's mean line is below my curve, some of his points are above it. Except at slow speeds the agreement between the experimental results and the curve of the equation is certainly sufficient to justify the acceptance of the equation as approximately true for the engine in question.

Again, it should be noticed that as a rule the larger engines are not being worked as hard as the smaller ones. This fact is attested by Professor Schmidt's results, those from the engine having the smallest cylinders and smallest boiler, checking most closely with my curve of maximum power. The truth is that the size of the fireman has not increased with the size of the engine and the result is that the very large engine for much of the time, runs comparatively light, but this statement in no way affects their ability to pull when they are given a chance. They get the chance in bringing trains up to speed and in working over maximum grades. Still again, I might add that even if moderation is shown in the amount of power that is demanded from the large engine, a gain in efficiency results, but this is another story. W. F. M. GOSS.

Urbana, Illinois,
May 8, 1902.

To the Editor of the Railroad Gazette:

I have noted Professor Goss' remarks on my contribution to your issue of March 7, in which the results of Professor Goss' formula for tractive effort are compared with the results obtained by our Dynamometer Car No. 17.

I have appreciated fully that the formula was intended to give maximum values of draw-bar pull, and this fact was not lost sight of in preparing the article referred to above.

From my observations of the work of the firemen and from my knowledge of the positions of throttle and reverse lever, I believe that the values of draw-bar pull given in the table on page 159 of your issue of March 8 represent—with the exceptions there noted—very nearly, if not quite, the maximum effort obtainable from these engines; certainly much more than the 75 per cent. of the maximum which the assumed correctness of the formula would imply. I may add that engines 639 and 640 each carried two firemen.

Since the publication of that article I have further checked the formula by applying it to Illinois Central Engine No. 46 of the same class as Engine No. 35, one of the four engines referred to above.

Three observations taken while that engine was working at its maximum—with wide-open throttle and reverse lever "in the corner," showed a difference between actual draw-bar pull and pull calculated by the formula of 28 per cent.

The observations were taken about 400 ft. from a point where the engine narrowly escaped stalling on account of lack of steam—with an efficient fireman and boiler and fire in good condition—circumstances which, I think, indicate maximum boiler performance.

Several other observations taken under similar conditions confirmed this result.

EDWARD C. SCHMIDT.

Master Car Builders' Reports.

STANDARDS AND RECOMMENDED PRACTICE.

There seem to be but few desires expressed for changes in the present standards and recommended practices. In view of the replies to the circular of inquiry your committee, however, begs leave to call attention to the following suggestions and recommendations. . . . The references are to the proceedings of 1901.

Standards.

Journal-box and contained parts for journal 5 by 9 in., sheets M. C. B.-13 and M. C. B.-14.

It has been suggested that experience has shown that the wedge-stop lugs on the outer edge of the journal-box for 5 by 9 journal are deficient in strength, and that they should be strengthened by an addition of metal on the front side, to make them conform to the lugs shown on the drawing for 5½ by 10 in. journal, and it is also suggested that the bottom of the box is not sufficiently strong for jacking purposes.

The committee concurs in the first suggestion, and would recommend modification of the standard for journal-box for 5 by 9 journals by increasing the size of the wedge-lug to correspond with that shown on the drawing for journal-box for 5½ by 10 in. journals, sheet M. C. B.-17.

The committee would also recommend that these lugs be extended laterally to the sides of the box, instead of leaving about ¼ in. opening, as at present.

Stenciling cars, page 506.

The Central Railway Club has presented to the Arbitration Committee a recommendation that cars be stenciled to enable inspectors to easily distinguish between the "A" and "B" ends of cars, as called for in the M. C. B. Rules of Interchange. . . . Your committee would recommend the adoption of the following addition to the present standards for stenciling cars:

"All freight equipment cars used in interchange shall be stenciled with a letter 'B' on the end of car upon which the brake-shaft is located, and with the letter 'A' on the opposite end. On cars having brake-shafts on both ends, the end toward which the brake-cylinder push-rod travels should be stenciled 'B,' and the opposite end 'A.' . . . The location of the lettering to be as near the center line of end of car as convenient, and where possible be not less than 10 in., nor more than 14 in., above the buffer block, on box, stock and other classes of cars having stationary ends, and to be located on the end-sill near the buffer-block, or on the face of the buffer-block near the top, on other classes of cars."

Recommended Practice.

It is recommended that the air-brake repair card should now be adopted as a standard of the Association, pages 515 and 516. The committee concurs in the recommendation.

Protection of Trainmen, sheet M. C. B.-A, pages 517, 518 and 519.

It is recommended that the provisions in this practice should be adopted as standard. . . . The recommendation with regard to steps is now somewhat indefinite. . . . The reference in this practice under the heading "Steps" should read as follows:

"Two good substantial steps, to be made of wrought iron, about ½-in. by 1½-in. section, to be fastened one to each side-sill, next to the corner of the car to which the ladder is attached, on cars having ladders, and to diagonally opposite corners on all other cars." The committee concurs in this suggestion.

It is further suggested that under the heading "Ladders," . . . the fifth line be changed to read as follows:

"Each ladder to have the handhold on the roof directly over the top of ladder, the handhold to run longitudinally with the car, and to be located about 4 in. from the side edge of the roof." The committee concurs in this suggestion.

. . . The committee would recommend that under the heading "Handholds," in each place where the location is mentioned, it be changed from the reading "about 27½ in. above the center line of drawbar" to read "not less than 18 in., nor over 30 in., above center line of drawbar." . . .

The committee recommends that the above changes be made in this recommended practice, and that the recommended practice, as amended, be adopted as a standard of the Association.

Uncoupling arrangement for M. C. B. couplers, page 520, sheet M. C. B.-B. It has been suggested by several members that this recommended practice could very properly be modified and improved; . . . that it is desirable to have the uncoupling rod extended so that it can be operated from both sides of the car, and also in connection with any type of coupler where the lock has to be supported by the uncoupling rod resting upon an inclined ledge, that in such couplers allowance should be provided for so that there can be a variation of at least three-quarters of an inch in the length of the uncoupling chain. The committee would suggest that it be put in the hands of a committee for consideration and recommendation to our next convention.

Mounting Wheels, page 522, sheet M. C. B.-E.

It has been recommended that the gage for locating wheels equidistant from center of axle, as shown on sheet M. C. B.-E. be adopted as a standard of the Association. The committee concurs in this recommendation.

Specifications for Air-Brake Hose.

It is suggested that item 7 of these specifications, covering the label for hose, as shown at the bottom of page 533 and top of page 534, and on sheet M. C. B.-G. be made a standard of the Association. The committee concurs in this recommendation.

Summarizing in conclusion, the committee would suggest that recommendations be submitted to letter ballot for adoption.

This report is signed by Messrs. A. M. Waitt (Chairman), T. W. Demarest, William Apps.

LABORATORY TESTS OF BRAKE-SHOES.

The committee report presented at the Association meeting of 1901 was rather exhaustive and covered the question of tests so thoroughly that there was nothing for this committee to do except to ascertain as far as possible what efforts were being made by the members of the Association to adopt the co-efficient of friction as recommended by the committee and later adopted as Standard by this Association.

Your committee therefore made inquiry by circular as to whether any of the members desired it to test the shoes being used, and the replies received from that inquiry would indicate that a very large percentage of the members are using shoes that were tested by our predecessors, and as the results obtained are satisfactory in nearly all instances, the necessity of another test so soon after the adoption of the co-efficient of friction as standard, was evidently considered as premature, and consequently no tests were made.

In connection with the Circular of Inquiry, the committee deemed it advisable to ascertain if possible the result of the continuous application of brakes on grade. From the replies received, the indications are that the results in some cases are disastrous to the wheels, causing overheating and checking of the tread, eventually forming comby spots and circumferential cracks in or adjacent to the throat, and surface cracks across the tread normal to the flange.

It has not been definitely determined, however, that the long-continued application of the brake is the real cause of this, but the fact that these conditions exist on roads having long, steep grades, more than on roads having light grades, would make it appear that there is room for further investigation along the lines of the effect of temperature, and that some effort should be made to obtain more knowledge in regard to the friction of brake-shoes and its effect upon cast-iron wheels under heavily loaded cars by continuous application of the brakes.

Your committee is of the opinion that steps should be taken wherever possible by members of the Association, to check the results obtained by the Committee on Laboratory Tests of Brake-Shoes, by making practical tests in actual service of shoes having the frictional qualities of the recommended standard. . . .

This report is signed by Messrs. J. E. Simons (Chairman), Geo. Gibbs, L. T. Canfield.

STANDARD AXLES AND SPECIFICATIONS.

The present M. C. B. specifications for axles have been in force since 1896, and therefore the oldest axles made according to these specifications are not more than six years old. The practical results, judged by the service these axles have given, lead your committee to believe that no serious errors have been made in either the design or the character of the steel specified. It is too soon, however, to speak positively on these questions, because an axle . . . fails eventually, due to the constant reversals of strain, and this must be repeated many thousands of times to result in failure. . . .

As to the possibility of making limiting weights and dimensions for axles, your committee does not feel that this is necessary. The dimensions adopted for different portions of the axle should be followed as closely as it is possible to do in practice, and by introducing the question of the limit of weight it simply becomes a disturbing factor. . . . Further, cases have come to the attention of your committee where axles bought on specifications requiring minimum weights have been found less in diameter at certain portions of the axle than required by the present M. C. B. drawings, and this, as is readily seen, will result in the axle being overstrained in that portion where it is less than the proper diameter.

In general, your committee feels that the present specifications should stand for another year at least, and until some definite information can be obtained which would lead to modifications. . . .

The Committee on Axles, reporting to the convention of 1901, recommended that the wheel seats of M. C. B. axles should be changed in order to allow more material for refitting wheels to the following dimensions:

Axle "A"......5⅛ in. Axle "C"......6½ in.
Axle "B"......5¾ in. Axle "D"......7 in.

And in addition that the center of axle "B" be made 4¾ in.

These recommendations were submitted to letter bal-

lot, which closed Sept. 14, 1901, the result of which was that the recommendations were adopted by the Association. When the drawings of these axles appeared in the proceedings of 1901, however, changes were made in the diameter of the tapered portion of the axle where it joins the fillet next to the rough collar. The diameter at this point should be approximately the same as that of the wheel seat when turned down to its limit, although somewhat less.

It was also found that the diameter of the rough collar was insufficient from a practical standpoint, in order to have this collar fulfil the functions for which it was designed.

After consulting a number of axle manufacturers, it appears necessary to have the diameter for the rough collar about ⅜ in. greater than the finished wheel seat. The usual practice in the forge shop, when axles are smooth-forged, is to make the diameter of the rough collar and wheel seat the same, allowing ¼ in. on the diameter for finishing, and, therefore, in this case the rough collar would be ¼ in. greater in diameter than the finished wheel seat. When the wheel seat is rough turned by the manufacturer, the diameter of the rough collar and the wheel seat are forged the same, but are made from ⅜ in. to $^7/_{16}$ in. greater than the finished wheel seat. This allows ¼ in. to be taken off in rough turning, and still leaves ⅛ in. on the diameter of the wheel seat for finishing when wheels are fitted on the axles.

Your committee submits with this report drawings of the M. C. B. axles A, B, C and D, showing the changes which they think necessary. . .

This report is signed by Messrs. E. D. Nelson (Chairman), William Garstang, James Coleman.

STANDARD METHODS OF CLEANING AIR-BRAKES AND ADDITIONAL PRICES FOR LABOR AND MATERIAL.

After carefully considering the matter we have decided that there cannot well be standard methods of cleaning air-brakes because of the varying conditions and facilities, any more than there can be standard methods of doing any other work. Dimensions and designs can be made standard, but we believe it will be best to recommend only standard practice for methods of cleaning air-brakes. With this understanding the following is offered:

The brake-cylinder and its parts need not be removed from the car for cleaning. [Detailed description of method follows.—EDITOR.]

The triple valve should be removed from the car for cleaning in the shop, to be replaced by a triple in good condition. [Details follow.]

Should the triple piston packing ring need to be renewed or the bushing require truing, we strongly recommend that this work be done by the manufacturers. We are thoroughly convinced that the average workman cannot, at least does not, do work of this kind satisfactorily, and that by far the largest proportion of the attempts to economize in this way result in inefficient air-brakes and slid flat wheels.

Usually sufficient attention is not paid to the condition of the emergency parts of the triple, as shown by their condition; the emergency valve seat is found distorted, the stem bent, the rubber seat imperfect and the check valve not properly fitting in a number of cases. These facts account for a large number of slid flat wheels. . . .

Testing Triples.

After cleaning and repairing it is essential that triples be tested and come within required limits, if a reasonable efficiency of the air-brakes is to be maintained.

Test No. 1.—The tightness of the slide valve, the emergency and check valves and all joints should be determined by painting with soap suds.

Test No. 2.—Maintaining a pressure of 90 lbs. in the train pipe, the auxiliary pressure should reach 70 lbs. in not less than 45 sec. or more than 60 sec., as provided in test No. 9 of the M. C. B. Air-Brake Tests.

Test No. 3.—To test repaired triples for release, charge the auxiliary to 70 lbs. pressure and make a full service reduction of 20 lbs., or until the auxiliary and cylinder pressure are equal. Place the special cut-out cock in such position that pressure must pass through the $^3/_{64}$-in. port, and turn main reservoir pressure of 90 lbs. into the train pipe. If the triple does not release under these conditions it should be condemned.

Test No. 4.—The triple piston packing ring should be tested for leakage by blocking the piston in the graduating position, preferably by use of the device shown at "A" in the accompanying diagram, maintaining the train pipe pressure at 70 lbs. Under these conditions the pressure in the auxiliary reservoir should not increase faster than 15 lbs. per minute. [The diagram is not reproduced.]

Prices for Labor on Air-Brakes.

We do not presume that the following schedule of prices for labor on air-brake work is perfect, but believe that the principle of having a fundamental key of prices covering the individual operations is well worth careful consideration. When this has been settled on it is only a question of determining the operations making up the total work involved in any piece of work and adding the key prices involved to get the proper price for the work.

The key prices given below have been tested in actual service for a short time and found to be fair. It is entirely possible that a longer trial will result in changes in details, without changing the principle involved. The committee is very largely indebted to Mr. J. M. Hines for the schedule of prices for labor.

In criticizing the prices given it should be borne in mind that they apply almost entirely to work done in the repair yards and involve delivering material and carrying tools from one point to another frequently.

Key to Schedule of Prices.

	Cents.
Nuts ⅝ inch or over, R. & R., 1 or 2 on same bolt	2
Nuts ½ inch or less, R. & R., 1 or 2 on same bolt	1
Union disconnected and connected	2
Nuts tightened when loose, each	1
Plugs oil, R. & R., each	1
Pins riveted, R. & R., each	3
Train or branch pipe disconnected and connected, or only connected, each connection	3
Spring cotters, R. & R., each	1
Staples, R. & R., each	1
Lag or wood screws, R. & R., each	1
Threads on pipe, cutting, per coupling	5
Pins connecting R. & R. (including split key)	2
Release valve, R. & R., each	2
Cap screws or studs or bolts, R. & R., each	1
Graduating stem nut, R. & R.	2
Emergency valve seat, R. & R.	5
Testing air (after repairs)	5

The following tables show how the proposed prices were arrived at by use of the key to the schedule of prices. The prices given include all labor. The letters "R. & R." mean "removed and replaced." For convenience in comparison, the present M. C. B. prices are given. It will be noted that in a number of cases there are no M. C. B. prices.

RULE 5, SEC. 23. The following table shows the charges allowable, in cents, for the items named in air-brake work, all labor included:

	Cents.		M. C. B. Cents.
Cylinder R. & R.			
Push rod, 1 connecting pin	2		
Clamping piston, 1 cap screw	1		
Cylinder head R. & R., 4 nuts ½ inch	4		
Disconnecting cylinder from reservoir, 7 nuts ½ inch	7		
Reclamping cylinder piston, 1 cap screw	1		
Removing cylinder from car, 6 nuts ⅝ inch	12		
	—	27	25
Reservoir R. & R.			
Removing from car, 2 nuts ⅝ inch	4		
Disconnecting from cylinder, 7 nuts ½ inch	7		
Removing release rods, 2 spring cotters	2		
Removing release valve	2		
Removing two plugs	2		
Removing triple valve, 2 nuts ⅝ inch	4		
Disconnecting union	2		
Disconnecting union retaining pipe	2		
	—	25	25
Cylinder and reservoir R. & R.			
Removing push rod, 1 connecting bolt	2		
Clamping cylinder piston, 1 cap screw	1		
Removing cylinder head, 4 nuts ½ inch	4		
Removing cylinder from car, 6 nuts ⅝ inch	12		
Removing reservoir from car, 2 nuts ⅝ inch	4		
Removing release rods, 2 spring cotters	2		
Removing release valve	2		
Removing two plugs	2		
Removing triple, 2 nuts ⅝ inch	4		
Disconnecting train pipe union	2		
Disconnecting retaining pipe union	2		
	—	37	25
Cylinder release spring R. & R.			
Removing push rod, 1 connecting pin	2		
Clamping cylinder piston, 1 cap screw	1		
Removing cylinder head, 4 nuts ½ inch	4		
Reclamping cylinder head, 1 cap screw	1		
	—	8	10
Cylinder gasket R. & R.			
Disconnecting triple union	2		
Disconnecting retaining pipe union	2		
Disconnecting reservoir block, 2 nuts ⅝ inch	4		
Disconnecting reservoir from cylinder, 7 nuts ½ inch	7		
Removing push rod, 1 connecting pin	2		
Clamping cylinder piston	1		
	—	18	20
Cylinder piston packing R. & R.			
Removing push rod, 1 connecting pin	2		
Clamping cylinder piston, 1 cap screw	1		
Removing cylinder head, 4 nuts ½ inch	4		
Removing leather packing, 4 nuts ½ inch	4		
	—	11	15
Cylinder piston R. & R.			
Removing push rod, 1 connecting pin	2		
Clamping cylinder piston, 1 cap screw	1		
Removing cylinder head, 4 nuts ½ inch	4		
	—	7	10
Removing packing leather expander (see cyl. piston)		7	
Removing slide valve, 3 nuts ½ inch		3	
Removing cylinder cap, 3 nuts ½ inch		3	
Slide valve R. & R., grinding in		33	40
Retaining valve R. & R., 2 wood or lag screws (2) valve (3)		5	
Repairing retaining valve (R. & R. 5)		10	15
Release valve R. & R.			
Disconnecting release rods, 2 spring cotters	2		
Disconnecting release valve	2		
	—	4	
Release valve, repairing (R. & R. 4)		9	10
Release valve rod R. & R., 1 spring cotter	1		
Removing staple	1		
	—	2	10
Triple gasket R. & R.			
Disconnecting union branch pipe	2		
Disconnecting union retaining pipe	2		
Removing triple, 2 nuts ⅝ inch	4		
	—	8	10
Triple, taking down and taking apart.			
Train pipe union	2		
Retaining pipe union	2		
Removing triple, 2 nuts ⅝ inch	4		
Check valve case, 2 cap screws	2		
Emergency valve seat	5		
Cylinder cap, 3 bolts	3		
Cleaning	5		
	—	23	20
Hose gasket R. & R.		2	3
Cylinder cleaned, oiled and stenciled.			
Removing push rod, 1 connecting pin	2		
Clamping cylinder, 1 cap screw	1		
Removing cylinder head, 4 nuts ½ inch	4		
Cleaning and stenciling	13		
	—	20	20
Angle cock R. & R. (hose 3)		6	5
Air hose R. & R.		3	
Angle cock handled R. & R., 1 riveted pin		3	5
Dummy coupler R. & R., 1 lag screw		1	5
Push rod R. & R., 1 connecting pin		2	
Train or branch pipe R. & R.			
For each connection made (M. C. B. "renewing 1 sec. 10")		3	10
Cylinder and reservoir tightened where loose, 8 nuts		8	10
Oil plugs R. & R., each		2	
Unions disconnected and connected		2	
Triple piston packing ring fitted		15	
Slide valve spring R. & R.			
Cylinder cap (3 cap screws)		3	
Removing riveted pin		3	
	—	6	
Emergency valve piston R. & R.			
Disconnecting union	2		
Removing check valve case, 2 cap screws	2		
Removing emergency valve seat	5		
	—	9	10
Emergency valve seat R. & R. (see E. V. piston)		9	10
Emergency valve rubber seat R. & R.			
Disconnecting union	2		
Removing check valve case, 2 cap screws	2		
Removing riveted pin	3		
Removing emergency valve nut	1		
	—	8	
Check valve case, spring, gasket, or all R. & R.			
Disconnecting union	2		
Check valve case, 2 cap screws	2		
Emergency valve seat	5		
	—	9	
Triple strainer R. & R.			
Disconnecting union	2		
Triple cylinder cap R. & R., 3 nuts ½ inch	3		
	—	5	5
Graduating nut, stem, spring, or all R. & R.		2	
Triple cylinder cap gasket R. & R., 3 nuts ½ inch		3	
Triple gasket R. & R.			
Disconnecting union (B pipe)	2		
Disconnecting union (R pipe)	2		
Removing triple, 2 nuts ⅝ inch	4		
	—	8	10
Cut-out cock R. & R.			
1 union disconnected	2		
2 pipe connections	6		
	—	8	15

Prices for Material for Air-Brake Work—No Credit for Scrap.

Angle cock, renewing	$1.40
Angle cock, handle	.08
Auxiliary reservoir	2.45
Coupling, dummy	.10
Cut-out cock	1.20
Cut-out cock handle	.08
Cylinder, body (8 by 12 inches)	1.60
Cylinder, piston and rod	.95
Cylinder, piston follower	.10
Cylinder, piston packing leather	.40
Cylinder, piston packing leather expander	.05
Cylinder, piston release spring	.50
Cylinder, non-pressure head	.50
Cylinder gasket	.05
Gasket, air hose coupling	.04
Pipe, nipple on end of train pipe	.10
Pressure retaining valve	1.00
Release valve	.70
Release rod	.10
Triple emergency valve	.55
Triple emergency valve seat	.50
Triple emergency valve piston	.45
Triple emergency valve rubber seat	.05
Triple emergency check valve	.25
Triple emergency check spring	.02
Triple emergency check case gasket	.08
Triple cylinder cap (drain cup)	.70
Triple cylinder cap (drain cup) gasket	.35
Triple graduating spring	.05
Triple graduating valve	.05
Triple graduating stem	.15
Triple graduating stem nut	.25
Triple check valve case	.80
Triple piston and ring	1.75
Triple piston ring (only)	.25
Triple slide valve	.90
Triple slide valve spring	.05
Triple valve strainer	.05
Triple valve gasket	.15
Train pipe air strainer (1¼ inch)	.55

In Rule 5, Sec. 24, we recommend that the price for air-brakes be made $27.50 and the change be made in Sec. 25 of the same rule.

This report is signed by Messrs. C. H. Quereau (Chairman), W. E. Symons, F. H. Scheffer.

EXAMINATION OF CAR INSPECTORS.

. . . While railroads usually exercise care in their selection of inspectors, endeavoring to get the best qualified men for the work, few roads have reduced to a system the employment and promotion of such men. . . .

In determining the proper age for inspectors we have had to bear in mind that vision and hearing, so important for men in this line of railroad work, begin to fail at 40 years of age. Glasses then become necessary, and glasses are not always successfully used in outdoor active work in all kinds of weather by car inspectors.

It has also been thought wise to map out a line of work that seems most desirable for the schooling of inspectors. The committee recommends:

One year at oiling cars.

Two years at car repairing.

Age limit for new men, 30 years.

Age limit for promoted men, 40 years.

Vision, 20-20 in one eye and not less than 20-40 in the other, without glasses. . . . [The committee then lays down directions for testing vision and hearing.]

The applicant should be able to write a legible hand in English, and also to read manuscript matter as well as printed matter.

The inspectors should be able to name each part of the cars in general use, in preference using M. C. B. dictionary terms.

Inspectors must pass a satisfactory examination on M. C. B. Rules, answering 75 per cent. of the questions submitted.

This report is signed by Messrs. G. W. Rhodes (Chairman), M. K. Barnum and Chas. Waughop.

REPORT OF THE COMMITTEE ON DRAFT GEAR.

"On account of the extent of the tests, the large number of gears tested and reported on and the amount of work required to put the results in shape, it has not been possible at this time to do anything more than present the facts as shown by the tests. The committee, therefore, has not attempted to draw any conclusions from the tests or to make any comparisons of the various gears.

"Your committee is of the opinion that in order to fully carry out the instructions given by the Association as to the nature of a final report on the subject of draft gear, that a series of road tests is necessary, whereby a record can be kept for a given period of the repairs necessary to the draft gear itself and to the other parts of the car independent of each other; also that a record be kept of the car mileage and tons hauled during that period, and it would recommend that a committee be appointed to carry these tests to a conclusion. It would then be possible to design a draft gear in conformity to the original instructions given the committee by the Association."

This is signed by E. D. Bronner, Chairman; Geo. F. Wilson, Mord Roberts, W. F. Kiesel, T. A. Lawes, C. M. Mendenhall, J. F. Deems and Wm. Forsyth.

The first part of this report gives a history of the organization of the Committee and the outline of the plan agreed upon between it and the manufacturers for making the tests, all of which has appeared from time

to time in the *Railroad Gazette*. Appendix A of the report includes details of the drop tests made at Altoona, Pa., illustrations of the appearance of the riggings after test, together with graphical statements showing the elas-

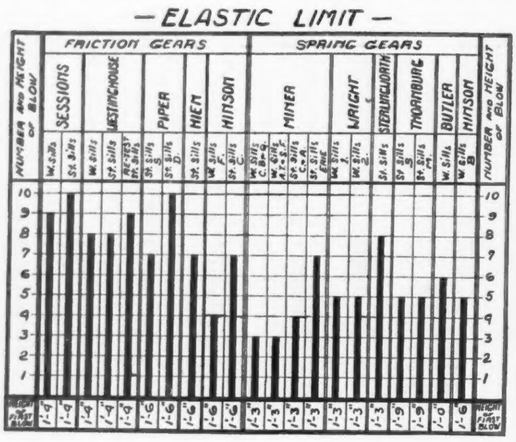


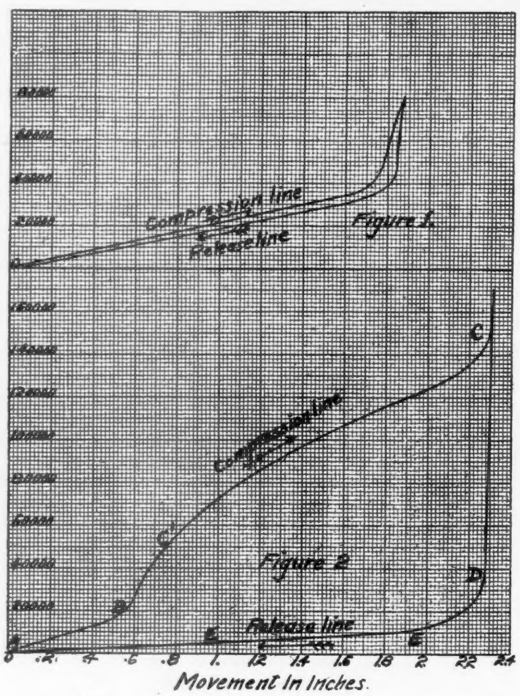
Fig. 1.

tic limit, ultimate strength and maximum rebound of the gears tested. These graphical statements are reproduced in Figs. 1, 2 and 3. Appendix B includes the results of the tests made at Purdue University, Lafayette, Ind., being a separate report to the committee signed by Prof. W. K. Hatt and Prof. William Forsyth. This report is in part as follows:

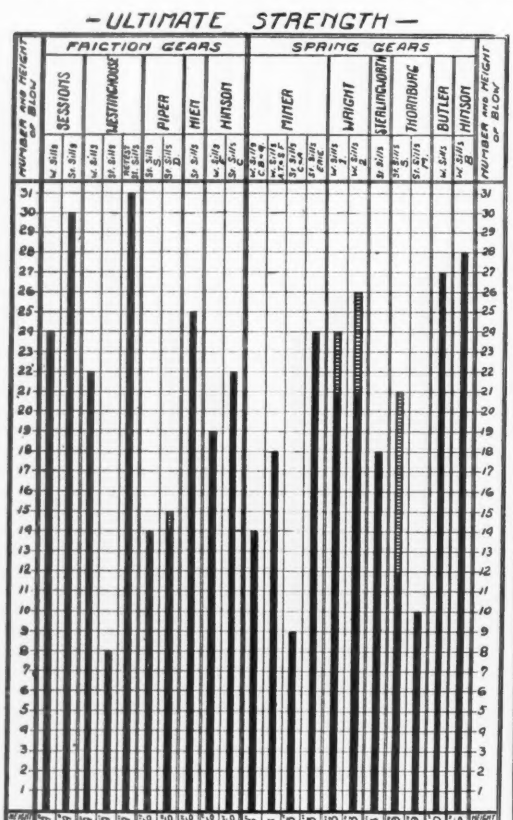
The static tests assigned to Purdue University, and, as given below, include tests in tension and compression of both spring and friction draft riggings, attached to both steel and wooden sills.

The purpose of these tests is to determine:

(1) *The Working Limit of the Riggings.*—To this end, uniformly increasing loads were applied to the riggings and corresponding movements of the yokes with reference to the sills were observed until the riggings became solid, thus giving what is called in the diagrams below the "compression line," that is, the "buffing line." In case of all friction gears, and in case of some spring gears, the load was then released step by step and the corresponding release curve obtained. The knowledge of this compression and release action is the most valuable part of the tests.

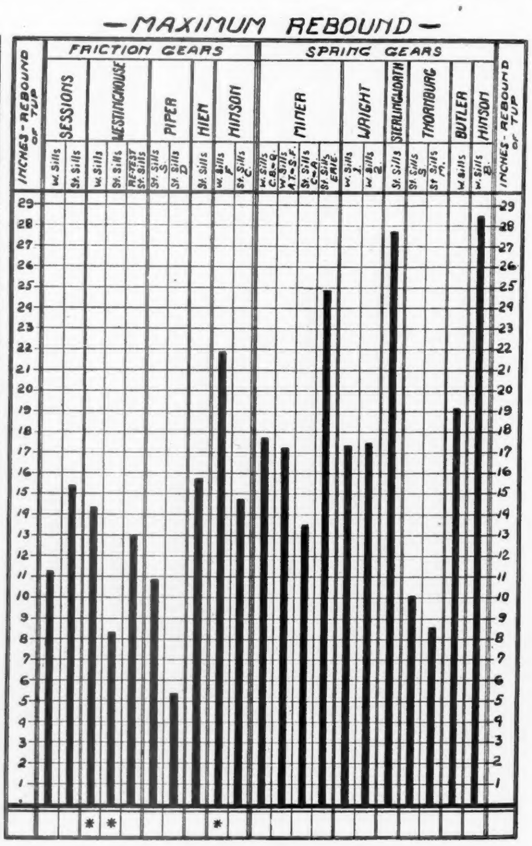


Typical Diagram of a Spring Draft Gear.



Note— Section lined parts show that test was carried beyond point of failure.

Fig. 2.



* Rebound still increasing when gear failed

Fig. 3.

(2) *The Load at Which any Part of the Coupler or Draft Attachments Might Fail.*—To this end, after the compression and release curve had been obtained, the loading was resumed just above the point at which the device became solid, and continued until some part of the rigging failed, or the capacity of the testing machine was reached.

(1) *Working Capacity.*—In case of spring gears, the working capacity is reached when the springs become solid. To determine this point, it was sometimes necessary to run the load slightly beyond the point of closing of the springs, in order to insure complete closing. In case of a theoretically perfect spring without constraint the line of release would follow back along the line of compression. This is not the case in the diagrams below, partly from the fact that the load was run beyond the point of solidity, and partly because of the friction of the parts of the gear. Fig. 1 gives a typical diagram of a spring gear.

In case of friction gear, the diagram is represented by Fig. 2. There is usually a free action of the device, giving, as is proper, a comparatively large movement for light loads (A-B). Then the device becomes less yielding under the action of the friction surfaces until solid under a high load (B-C'-C). On release the friction holds the device solid until a low load is reached (C-D), when the springs force the yoke gently back to the free position of the gear (D-E-A).

The elements of this test of friction gear, which are of value, are:

(a) *The free movement* of the device under light loads, that is, the length A-B before coming to the steep part of the curve; (b) *the capacity* of the gear before becoming solid, as shown by the load and energy absorbed up to C; (c) the action of the friction in *recoil*, as shown by the length C-D and by the area (expressed in terms of foot-pounds of work) between the compression line and the release line. These elements are listed in case of the gear tested in Table 2.

(2) *Load at Failure.*—It may be said that only in some cases does the load at failure in the tests below have any connection with the strength in service, for the reason that the attachments used in the tests are not under the same action that exists in the case of these attachments in car construction. That is, there was a tendency for the sills as used in the tests to fail by buckling slightly, thus throwing the bearing mainly on one edge of the sill. This was attended with a crushing of the sills where they bore on the platform of the testing machine at a load under which the lug bearings on these sills and the coupler attachments were unharmed. It is thought that the sills in the car under service are not subjected to the same strain as in the tests.

However, in many cases, the failure under test was due to crushing of lug bearings on sills, bending of follower plates or housings, and these are to be classed as true failures of the rigging, distinct from the failure due to the method of support in test.

Conclusions.—As this report confines itself to statements of fact concerning the tests, no attempt will be made to institute comparisons between the various gears, or their availability for service.

(*Continued on page 470.*)

Competitive Locomotive Types for the Illinois Central.

[WITH AN INSET.]

The two types of locomotive shown in the accompanying engravings have been recently received from the builders by the Illinois Central, the Atlantic type from the Baldwin Locomotive Works and the Prairie type from the Rogers Locomotive Works. They are from designs by Mr. William Renshaw, Superintendent of Machinery, and are the first wide fire-box passenger locomotives to be used on the road. They have been placed in fast passenger service and their performance will be very carefully watched by the motive power department. The results are expected to determine which of the two types will be adopted for general use. The Prairie type is the heavier, having a total weight of 203,000 lbs. against 178,600 lbs. for the Atlantic, while the tractive powers, based on 85 per cent. of the boiler pressure, are 25,500 and 24,100 lbs. respectively. The Atlantic type carries 95,710 lbs. on drivers, 39,290 lbs. on the front truck and 43,600 lbs. on the trailing truck. The driving wheels are 79 in. in diameter and have cast-steel centers and Krupp tires. The driving wheel base is 7 ft. 3 in. and rigid wheel base is 15 ft. 9 in., which will allow the engine to pass curves of six degrees; the total wheel base is 27 ft. 9 in. The Prairie type has 144,000 lbs. on drivers, 22,000 lbs. on the front truck and 37,000 lbs. on the trailing truck. The driving wheel base is 13 ft. 6 in. and the total wheel base is 30 ft. 9 in. The driving wheels are 75 in. in diameter and are similar in construction to those of the Atlantic type. Both types have 20 x 28 in. cylinders, with balanced D-slide valves.

Both boilers are of the extended wagon top radial-stay type, with sloping back sheet and head, designed for a working steam pressure of 200 lbs. The Atlantic type is 66 in. in diameter at the outside of the first course and the sheets are $^{11}/_{16}$ and ¾ in. thick. There are 351 tubes, 2 in. outside diameter and 16 ft. 6 in. long, affording a heating surface of 3,017 sq. ft.; the total heating surface is 3,191.7 sq. ft. For the Prairie type the diameter of the barrel is 68 in. and the sheets are ¾ in. thick. The tubes, of which there are 335, are 2 in. outside diameter and 19 ft. long. This is said to be the longest boiler ever turned out of the Rogers Works. The total heating surface is 3,534 sq. ft., of which 201 sq. ft. is in the fire-box and 3,333 sq. ft. in the tubes. The fire-boxes are of the same dimensions, 102 in. long and 72 in. wide, making a grate area of 51 sq. ft. The fuel used is bituminous coal.

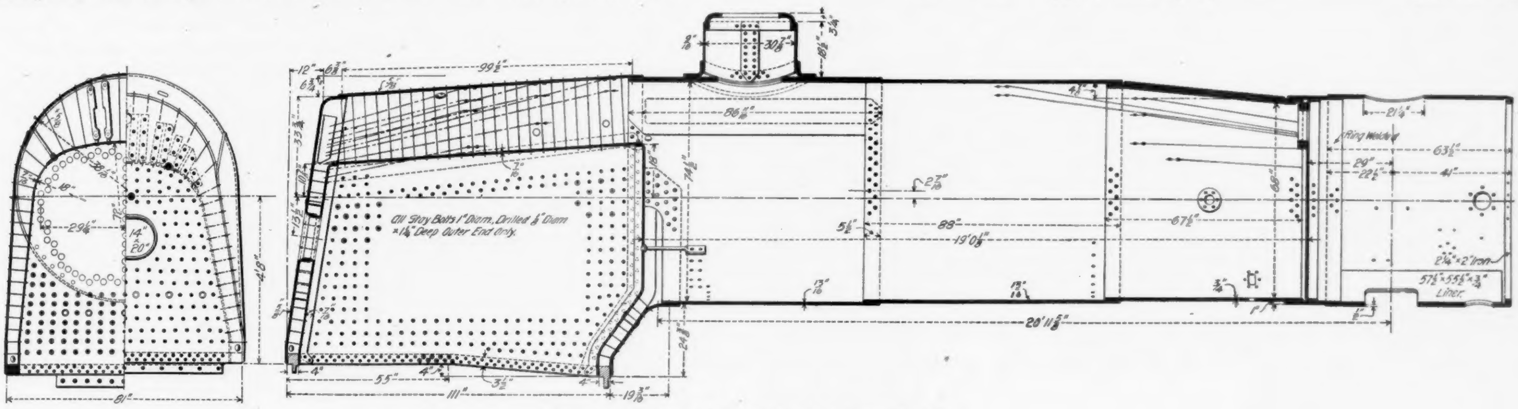
The tenders have steel underframes and are the standard type of the Illinois Central. They have a capacity for between 15 and 18 tons of coal and 7,000 gals. of water, and weigh 147,600 lbs. loaded. They are carried on 50-ton Fox pressed-steel trucks, having 38-in. steel-tired wheels with 5½ x 10-in. journals and are equipped with Westinghouse friction draft gear. Chain coal gates have been adopted for these engines. Gates of this pattern have been in use on some of the engines of the Pittsburgh, Cincinnati, Chicago & St. Louis for some time and have advantages over other forms in general use, in that the coal may more readily be broken with the pick and the chains may be removed singly from the hooks supporting them.

The Prairie type engine just completed by the Rogers Locomotive Works, is designed, like the Atlantic type, above referred to, for heavy fast passenger traffic. The frame bracing of this engine presents an interesting feature. The foot plate at the back is very short, and in order to effectively brace the frames together, so as to prevent any possible tendency of racking, a cast-steel plate is bolted across the frames, just behind the cylinder saddle. The plate is 69¾-in. long and is secured by vertical bolts through the frame and also through flanges which lie against the inner surface of the frames. There are four boiler-waste braces to frames and the diagonal smoke-box braces are retained. Both injectors are placed on the right side; one is a Nathan Simplex No. 11, and the other a No. 10, Ohio. Provision has been made for oiling the driving-boxes from the cab, and the pipes used for this purpose pass down outside the lagging.

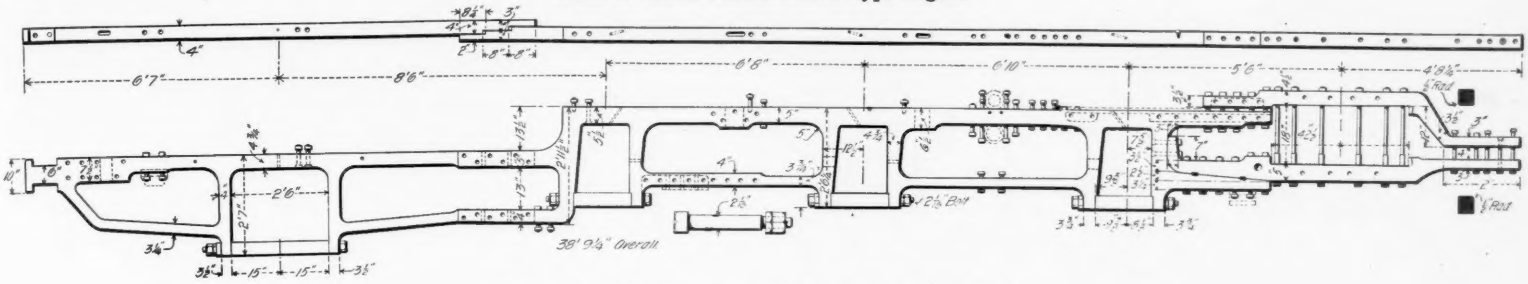
The carrying wheels are equalized with the rear drivers the equalizer bar having three pivot holes, by which the weight on the drivers may be altered in the shop, within certain limits, if considered desirable. The carrying wheels have about 6-in. side motion, though the truck is not of what is usually called the radial type. Upon the carrying axle boxes a cast-steel yoke is placed, which turns down on the sides of the boxes and has in each turned down end two pins from which a solid link hangs down and is pinned at the bottom to a block which unites two equalizer plates. These two plates are placed on each side of the main frames. The object of the two pins through the upper end of the solid link is to bring the truck back positively to central position when it has moved to either side, and the truck rides more steadily in consequence. There being no jaws for the boxes to work in their fore and aft position is maintained by a radius bar, similar to that of the pony truck in front.

The frame splicing just back of the cylinders is a very substantial piece of work. The lower member of the frame front is very securely bolted and keyed to the main frame in the usual way and has a turned up end or foot which is drawn up tightly against the outside of the forward jaw. The upper members are bolted vertically through the steel frame plate which lies between them and of which mention has already been made. Two flanges, one above and one below, are secured to the two upper frame members. There are, then, a total of nine

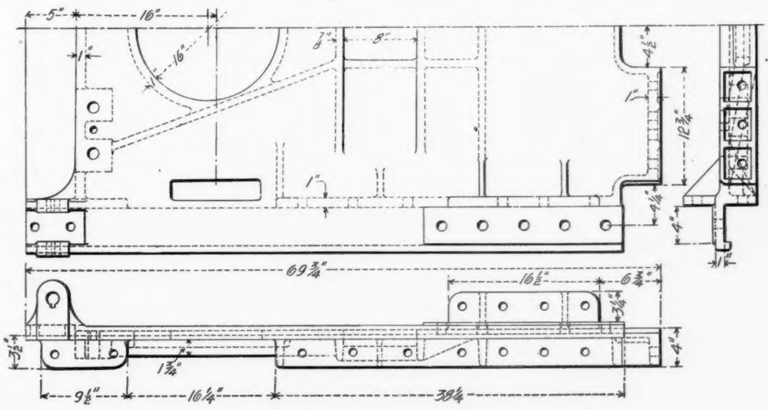
bolts through each member. If the cylinders were not there the frame splice, and, indeed, both frames, would be united in very strong and rigid connection. The frame members are not only bolted together but they are tied together on the inner side by the flanges of the steel frame plate. The back portion of the frame has an offset of 2 in. and the splice is bolted and keyed in approved fashion.



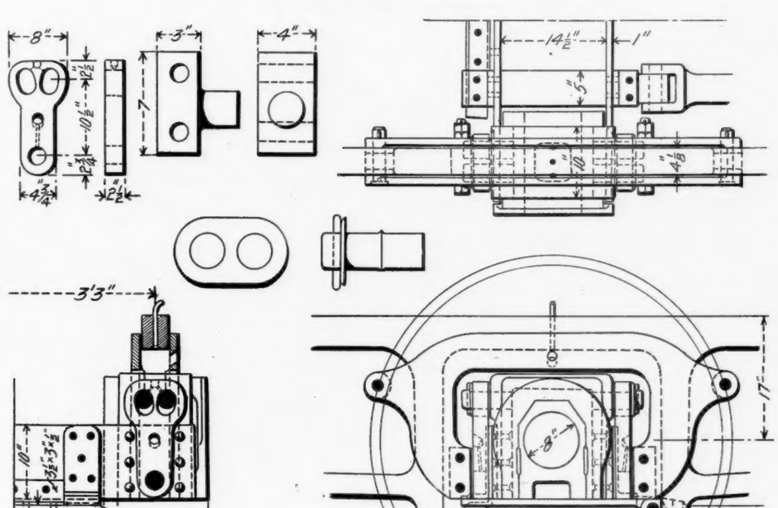
Boiler of Illinois Central Prairie Type Engine.



Frame of Prairie Type Engine—Illinois Central Railroad.



Details of Front Frame-Brace—Prairie Type Engine.



Details of Carrying Truck, Prairie Type Engine—Illinois Central.

A few of the principal dimensions of both engines are given below:

Atlantic Type—Baldwin.

Wheel base, total, of engine	27 ft. 9 in.
Wheel base, driving	7 ft. 3 in.
Wheel base, total, engine and tender	59 ft. 6½ in.
Length over all, engine	40 ft. 1½ in.
Length over all, total, engine and tender	67 ft. 8½ in.
Height, center of boiler above rails	9 ft. 1½ in.
Height of stack above rails	15 ft. 1¼ in.
Drivers, material of centers	Cast steel
Truck wheels, diameter trailing	48 in.
Truck wheels, diameter engine	36 in.
Journals, driving axle, size	9½ x 12 in.
Journals, truck axle, size trailing	8½ x 12 in.
Journals, truck axle, size engine	6 x 12 in.
Main crank pin, size	6¼ x 6½ in.
Piston rod, diameter	4 in.
Steam ports, length	20 in.
Steam ports, width	1½ in.
Exhaust ports, length	20 in.
Exhaust ports, width	3 in.
Bridge, width	1½ in.
Valves, kind of	Richardson balanced
Valves, greatest travel	6 in.
Valves, outside lap	1 in.
Valves, inside lap or clearance	Line and line
Boiler, type of	Extended wagon top
Boiler, working steam pressure	200 lbs.
Boiler, material in barrel	Carbon steel
Thickness of tube sheets	⅝ in.
Thickness of crown sheet	7/16 in.
Crown sheet stayed with	Radial stays
Dome, diameter	32 in.
Fire-box, material	Carbon steel
Fire-box, thickness of sheets	7/16 in.
Fire-box, water space, width	Front, 4 in.; sides, 4 in.; back, 4 in.
Grate, kind of	Rocking
Tubes, material	Nat. Tube Wks. I. C. special
Tubes, outside diameter	2 in.
Tubes, length over sheets	16 ft. 6 in.
Smoke-box, diameter	68½ in.
Smoke-box, length	73 in.
Exhaust nozzle	Single
Exhaust nozzle	Permanent
Netting	Wire
Netting, size of mesh	3½ x 3½ in.
Stack	Straight
Stack, least diameter	19½ in.
Stack, greatest diameter	19½ in.
Stack, height above smoke-box	3 ft. 1½ in.

Tender.

Type	Swivel trucks
Kind of material in tank	Steel
Thickness of tank sheets	¼ in.
Truck with	Swinging bolster
Type of truck spring	Elliptic and helical
Diameter of truck wheels	38 in.
Diameter and length of axle journals	5½ x 10 in.
Distance between centers of journals	6 ft. 5 in.
Diameter of wheel fit on axle	7 in.
Diameter of center of axle	5⅞ in.
Length of tender frame over bumpers	27 ft. 7 in.
Length of tank	24 ft. 9½ in.
Width of tank	10 ft. 0 in.
Height of tank, not including collar	5 ft. 0 in.
Height of tank over collar	6 ft. 6 in.

Prairie Type—Rogers.

Wheel base, total, of engine	30 ft. 9 in.
Wheel base, driving	13 ft. 6 in.
Wheel base, total, engine and tender	62 ft. 2 in.
Length over all, engine	42 ft. 9½ in.
Length over all, total, engine and tender	71 ft. 10¼ in.
Height, center of boiler above rails	9 ft. 2 in.
Height of stack above rails	15 ft. 0 in.
Material of driving wheel centers	Cast steel
Truck wheels, diameter	Leading, 33 in.; trailing, 48 in.
Journals, driving axle, size	9½ x 12 in.
Journals, truck axle, size	Leading, 6 x 12 in.; trailing, 8 x 12 in.
Main crank pin, size	7¼ x 5½ in.
Piston rod, diameter	4 in.
Kind of piston rod packing	United States
Steam ports, length	20 in.
Steam ports, width	1½ in.
Exhaust ports length	20 in.
Exhaust ports, width	3 in.
Bridge, width	1½ in.
Valves, kind of	American balanced, double disc
Valves, greatest travel	6 in.
Valves, inside lap or clearance	Line and line
Valves, outside lap	1 in.
Boiler, material in barrel	Carbon steel
Thickness of tube sheets	⅝ in.
Thickness of crown sheet	7/16 in.
Crown sheet stayed with	Radial stays
Dome, diameter	32 in.
Fire-box, material	Carbon steel
Fire-box, thickness of sheets	7/16 in.
Fire-box, water space, width	Front, 4 in.; sides, 4 in.; back, 4 in.
Grate, kind of	Rocking
Tubes, material	I. C. special
Tubes, outside diameter	2 in.
Tubes, length over sheets	19 ft. 0 in.
Exhaust nozzle	Single
Netting	Wire
Netting, size of mesh	3½ x 3½ in.
Stack	Straight
Stack, least diameter	16½ in.
Stack, greatest diameter	19½ in.
Stack, height above smoke-box	2 ft. 8 in.

Tender.

Type	Swivel trucks
Kind of material in tank	Steel
Thickness of tank sheets	¼ in.
Truck with	Swinging bolster
Type of truck spring	Elliptic and helical
Diameter of truck wheels	38 in.
Diameter and length of axle journals	5½ x 10 in.
Distance between centers of journals	6 ft. 5 in
Diameter of wheel fit on axle	7 in.
Diameter of center of axle	5⅞ in.
Length of tender frame over bumpers	27 ft. 7 in.
Length of tank	24 ft. 9½ in.
Width of tank	10 ft. 0 in.
Height of tank, not including collar	5 ft. 0 in.
Height of tank over collar	6 ft. 6 in.

The Per Diem Agreement.

As announced in the *Railroad Gazette* of last week, the agreement to adopt the per diem basis for the interchange of freight cars, for one year from July 1, has been signed by the owners of much more than two-thirds of the freight cars of the country. The names of the roads which have signed are given in the list below, which is taken from a circular sent out by Secretary W. F. Allen. The circular gives the names of subsidiary roads, as, for example, under the head of Great Northern we find the Eastern of Minnesota, the Montana Central, etc.; but as in substantially all cases the parent road has brought in all of its subsidiaries it is scarcely necessary to reproduce the full list here.

Including the subsidiary companies there are in this list 203 names; without them there are 132. The number of votes in favor of per diem (180) represents *member-*

ships based, in the case of large companies, on the number of cars owned; this explains the discrepancies in the totals. In the second list, containing names of companies which are not members of the American Railway Association, there are 32 entries.*

List of railroad companies holding memberships in the American Railway Association on behalf of which "Per Diem Rules Agreements" have been filed up to June 10, 1902:

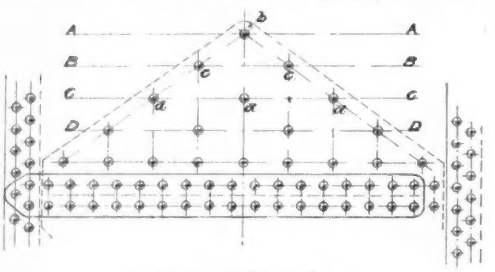
Atchison, Topeka & Santa Fe.	Lehigh & Hudson River.
Atlantic Coast Line.	Lehigh Valley.
Balt. & Annap. Short Line.	Long Island.
Baltimore & Ohio.	Louisiana & Arkansas.
Balt. & Ohio Southwestern.	Louis., Hen. & St. Louis.
Bessemer & Lake Erie.	Macon & Birmingham.
Blackwell, Enid & Southw'n.	Maryland & Pennsylvania.
Boston & Albany.	Mexican Central.
Buffalo, Roch. & Pittsburgh.	Mexican International.
Bur. & Mo. River R. in Neb.	Michigan Central.
Burlington & Northwestern.	Minneapolis & St. Louis.
Bur., Cedar Rapids & North'n.	M. St. P. & Sault Ste. Marie.
Butte, Anaconda & Pacific.	Miss. River & Bonne Terre.
Cammal & Black Forest.	Missouri, Kansas & Texas.
Canadian Pacific.	Missouri Pacific.
Carolina & North-western.	Muscatine North & South.
Carrabelle, Tallahassee & Ga.	New York & Ottawa.
Central New England.	N. Y. Cen. & Hudson River.
Central of Georgia.	N. Y. Chic. & St. Louis.
Central Railroad of N. J.	N. Y., Ontario & Western.
Central Vermont.	N. Y., Phila. & Norfolk.
Chesapeake & Ohio.	Norfolk & Southern.
Chicago & Alton.	Norfolk & Western.
Chicago & Eastern Ill.	Northern Pacific.
Chic., Burl. & Quincy.	Oregon Short Line.
Chicago Great Western.	Parral & Durango.
Chic., Indian. & Louisville.	Peoria & Pekin Union.
Chic., Kal. & Saginaw.	Pennsylvania Railroad System.
Chicago, Peoria & St. Louis.	Penn. Lines, W. of Pittsburgh.
Chi., Rock Island & Pacific.	Philadelphia & Reading.
Chic., Rock Island & Texas.	Pinehurst.
Cin. & Muskingum Valley.	Pittsburgh & Lake Erie.
Cin., Hamilton & Dayton.	Pittsburgh, Lisbon & Western.
Cincinnati Northern.	Pittsb'gh, Shawmut & N'th'n.
Cin., Richmond & Muncie.	Plant System.
Cleveland, Akron & Columbus.	Quincy, Omaha & Kan. City.
Clev., Cin., Chic. & St. Louis.	Rich., Fred. & Potomac.
Colorado & Southern.	Rio Grande, S. M. & Pac.
Columbus, San. & Hocking.	Rutland.
Cumberland & Pennsylvania.	St. Louis & North Arkansas.
Cumberland Valley.	St. Louis, Kan. City & Col.
Dav., R. I. & Northwestern.	St. Louis South-western.
Delaware & Hudson.	San Antonio & Aransas Pass.
Delaware, Lacka. & Western.	Santa Fe Pacific. (Including all California lines.)
Denver & Rio Grande.	
Detroit & Mackinac.	Santa Fe, Pres. & Phœnix.
Dry Fork.	Seaboard Air Line.
Duluth & Iron Range.	Southern Indiana.
East Broad Top.	Southern Pacific.
Erie.	Staten Island Rapid Transit.
Grand Rapids & Indiana.	Terre Haute & Indianapolis.
Grand Trunk.	Texas Midland.
Great Northern.	Toledo, Peoria & Western.
Gulf, Colorado & Santa Fe.	Toledo, St. Louis & Western.
Hannibal & St. Joseph.	Toronto, Hamilton & Buffalo.
Hocking Valley.	Union Pacific.
Houston & Texas Central.	Wabash.
Hunt. & Broad Top Mount.	Wash. & Columbia River.
Illinois Central.	Western Maryland.
Illinois Southern.	Western Ry. of Alabama.
Indianapolis Union.	W. Va. Central & Pittsburg.
Intercolonial.	Wheeling & Lake Erie.
Iowa Central.	Wheeling Terminal.
Jacksonville & St. Louis.	Williamsport & North Branch.
Keokuk & Western.	Wisconsin Central.
Lake Erie, All. & Wheeling.	Wrightsville & Tennille.
Lake Shore & Mich. Southern.	

List of railroad companies not members of The American Railway Association on behalf of which "Per Diem Rules Agreements" have been filed:

Atlantic & Birmingham.	Midland.
Buffalo, Attica & Arcade.	Nashville & Sparks.
Carolina Northern.	Newburgh, Dutchess & Conn.
Cen. Penn. & Western.	New River, Holston & W't'n.
Chic., Rock Island & El Paso.	Norwood & St. Lawrence.
Chic., Rock Island & Mexico.	Poughkeepsie & Eastern.
Cin., Lebanon & Northern.	Randsburg.
Coahuila & Pacific.	Sandersville.
Dominion Atlantic.	Saline River.
Fort Smith & Western.	San Pete Valley.
Houston, E. & W. Texas.	Savannah & Statesboro.
Kishacoquillas.	Sebasticook & Moosehead.
Leavenworth & Topeka.	Sylvania.
Lexington & Eastern.	Tuskaloosa Belt.
Little River Valley.	Waynesburg & Washington.
Mexican Northern.	Yreka.

An Improvement in Boiler Seams.

Mr. S. M. Vauclain, of the Baldwin Locomotive Works, has recently patented a new form of re-enforced butt seam which is applicable to the longitudinal seams of boilers and, in fact, to any seam under tension. The drawing shows in plan the form of seam. The two abutting plates are lapped on one side with a narrow strip and on the other with a diamond shaped plate extending the length



An Improved Boiler Seam.

of the joint. On the line A A, the sheet is entire with the exception of the single rivet hole b, through the plate and diamond sheet. On the line B B two holes, c c, are put through, but the plate is here re-enforced by the shear of the rivet b, so that the actual strength on this line is equal to that on line A A. Three holes, d d d, are put through the two plates on the line C C, but here they are re-enforced by the shear of the three rivets, b and c c, nearly equal to the amount cut out. A still better distribution is had on line D D, where four holes are cut out but are re-enforced by the shear of six rivets. The same effect is obtained in all the rows until the center of the seam is reached. It will be seen that the weakest place in the joint is on the lines A A and B B, the farthest from the actual joint of the two plates. The diamond shape plate extends and is secured in the same manner on both sides of the butt joint, preferably on the inside of the ring, and an ordinary outside lap strip is riveted over the joint.

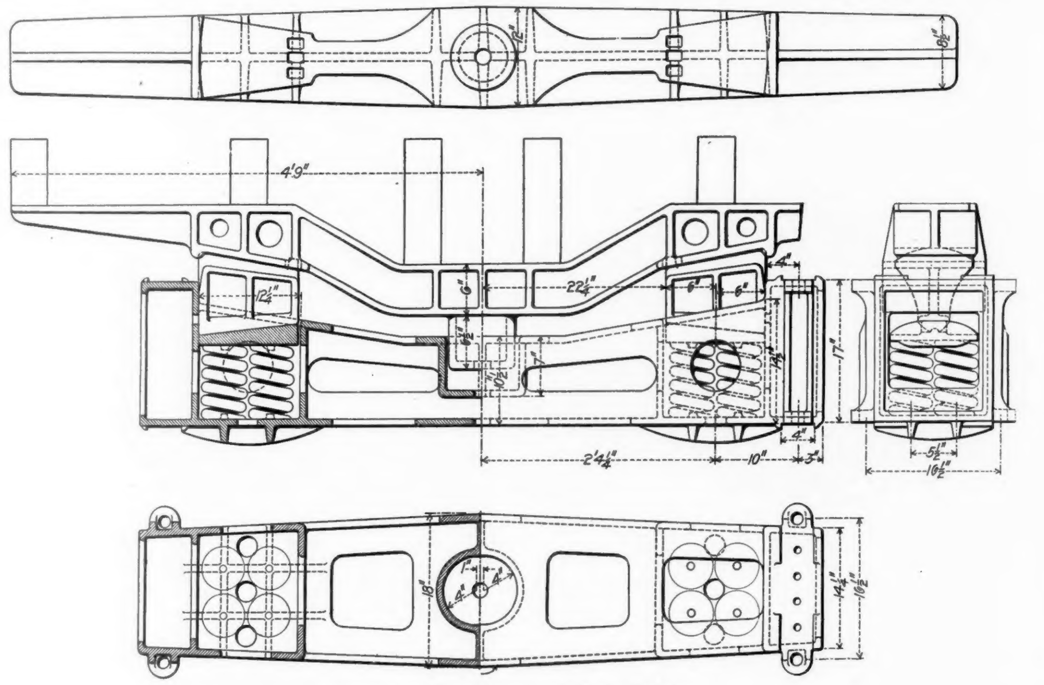
Actual experiments with drums riveted in this manner and subjected to bursting pressure show that very nearly the full strength of the plate is maintained. These seams are to be used on 75 Prairie type locomotives for the Atchison, Topeka & Santa Fe, now building.

*See note in editorial column.

A New Design of Metal Freight Car Truck.

The Buckeye Malleable Iron & Coupler Company, on the completion of its new steel casting plant, will put on the market a number of cast-steel specialties, one of which is here shown. This is an all metal truck designed to carry all the load on frictionless side bearings, a radical departure in truck design.

The truck transom is a single steel casting with the springs placed directly beneath the side bearings, insuring contact at the side bearings at all times and at the same time reducing the maximum bending moments in the transom to a comparatively small figure. The roller side bearing used is one patented by Mr. S. P. Bush, which has been thoroughly tested under locomotive tenders and found to meet all requirements. It consists of a segment of a large roller having a 12 in. fall so situated that in



Buckeye Cast Steel Truck and Body Bolster.

any position of swiveling the load is directly transmitted in a vertical line to the spring cap. Teeth on the large roller engage pockets in the body bolster, so that the correct position of the parts is always maintained. Tests show that the friction of this bearing under heavy loads is less than that of the ordinary center plate type with side bearings of small rollers. The springs and side bearings being placed inside the transom are well protected.

The bending moment of the body bolster is much reduced and the point of maximum bending moment transferred from the center of the bolster to points outside the side bearings. This reduction of bending moment enables a lighter section to be used than in other designs and a consequent reduction in weight. At the side bearings there is always room to make the bolster any depth required to provide for the bending moment and the reduction of this figure at the center of the bolster allows the section at that point to be cut away enough to place the body bolster entirely beneath the sills. This form of construction has many advantages in very low cars or cars having deep center sills. The drawing shows the truck applied to a car having 15 in. center sills and 8 in. side sills. If the sills are of uniform depth the truck transom is arched upward in the center to suit the body bolster. If a large amount of side play is required the design is capable of modification to suit the Barber device.

Local Freight Agents' Annual Meeting.

The fifteenth annual meeting of the American Association of Local Freight Agents' Associations was opened by President T. P. Adams, in the Chamber of Commerce, Cleveland, on June 10, with speeches of welcome by Mayor Tom. L. Johnson and Colonel J. J. Sullivan, Vice-President of the Chamber of Commerce. Responses were made by Messrs. Bumpas, Judge and Arnold. Subsequent sessions were held in Hollenden Hotel. The number of delegates reporting was 134, representing 40 associations, many delegates arriving after the committee had reported.

The reports showed the Association to be in a most flourishing condition, numerically and financially; and they gave evidence of enthusiasm among the local Associations. Great activity exists in the committees charged to bring about uniform methods, and the recommendations of this Association are for the most part favorably received and adopted.

At the meeting last year the name of the Association was changed from "National" to "American," and the scope of its territory extended to the bounds of North America; and three Canadian cities, Montreal, Toronto and London, applied at this meeting for membership and were admitted. Other cities applying and admitted were, Knoxville, Tenn.; Wichita, Kan.; Savannah, Ga., and Terre Haute, Ind. The Association now embraces 64 cities with an individual membership of 633.

The Treasurer reported all dues paid, likewise all bills, and the handsome balance of over $900 in the treasury.

The Special Committee with President Adams at its head, who responded to the request of the Classification Committee that the Local Agents' Association draft a form of a uniform bill of lading, shipper's receipt and shipper's order, submitted a triplicate form embodying many features recommended by the respective local Associations. The report was fully discussed, occupying all of Tuesday evening's session, and was referred to a special committee with instructions to make a report to the President, to be transmitted to the sub-committee on classification.

The per diem rules to take effect July 1 were distributed on Tuesday, and the subject was made the order of business for Wednesday. It occupied the time of the convention a half day. The members confined themselves to those features which will be likely to affect the station agent. An explanation as to ending daily records at midnight, instead of a more seasonable hour, was not given; though a reason doubtless exists. Some confusion is anticipated between the delivering and receiving lines on account of possible disputes as to hours of delivery. It was advocated by some that where switching lines were compelled to refuse freight for consignees whose receiving tracks were blocked by their own consignments that the delivering line should collect demurrage direct from such consignees for detention on that company's tracks while waiting to make delivery to the switching line. Otherwise, consignees would take advantage of this condition to hold freight in proximity without paying for the privilege.

The Secretary was instructed to distribute printed copies of the discussion on this subject, sending one to each individual member.

Upon a proposition submitted by Cincinnati, it was almost unanimously agreed that freight houses ought to be closed at 4:30 on all days but Saturday, and as much earlier on Saturday as local conditions would permit. The interests of the punctual shipper should not be injured by the tardy one; fast schedules should be maintained, to the welfare of general commercial interests.

The Conference Committee was instructed to take up with the Classification Committee the matter of providing a classification of articles too large to be loaded in a 36 ft. car. This was recommended by LaCrosse, Wis.

That tracers should not be sent by forwarding agents unless some evidence from consignee be produced that shipment had not been received after a reasonable time was decided upon as a panacea for the ills complained of by Pittsburgh.

Chicago wants agents to be more particular in checking and handling empty beer packages. If the efforts of the Conference Committee avail, they will be so.

Increase in damage to freight in packages, Toledo alleges, is due, half to poor packages and the other half to the increased size of cars, rough handling due to air-brakes and bad loading. The Association will ask the Freight Claim Agents' Association to join in getting the classification made more specific as to what constitutes proper protection in the construction of packages. It was resolved that agents should exercise eternal vigilance and request transportation officials to do likewise.

Buffalo recommended that receipts for L. C. L. ship-

ments be taken on platform by clerk making delivery; this was supported by a unanimous vote.

Wheeling asked that a uniform time limit be named when team and house freight should be sent to public storage. It was thought that conditions differed so as to make a given time applicable to all cities impracticable; but it was agreed that all Associations should recommend the shortest limit consistent with local conditions.

New York's topic, protection to agents delivering shipments sent in bond and consigned to order without the surrender of the original bill of lading, was referred to the Conference Committee for report at the next meeting.

In answer to Louisville, the Conference Committee was instructed to inform local associations that bills for company material delivered by a connecting line should be paid promptly as other bills.

St. Louis was informed, by the vote of the Association, that generally speaking, carload freight received from connecting lines on billing not showing final destination, should either not be accepted or, if placed on hold tracks, switching should be charged; but local requirements should govern.

W. H. Bumpas (L. & N.), Nashville, was elected President; James Caldwell, Jr. (Grand Trunk), Detroit, Vice-President; George W. Dennison (Penna. Co.), Toledo, Secretary, and C. H. Newton (Wabash), Toledo, Treasurer. Savannah, Ga., was chosen as the place, and June 9, 1903, as the time for holding the next meeting.

The entertainment features were art galleries and tally-ho drives for the ladies, a reception and ball on Wednesday evening, and a theatre party on Thursday evening; and there was instructive sightseeing in a trip over ore and lumber docks and one to Akron and Barberton.

After passing appropriate resolutions upon the death of deceased members and thanks for courtesies of Cleveland Association and their friends who assisted in entertaining the delegates and their families, the meeting adjourned.

The Thornburgh Coupler Attachments.

This is a tandem spring gear with box followers. It is shown in Fig. 1 as applied to steel sills for testing in accordance with the specifications of the M. C. B. committee. Fig. 2 shows details of the box followers made in three parts as shown, one solid and two interchangeable separable pieces. When the springs are in place and the box followers between the yoke the whole forms an interlocked collapsible double spring case, with a movement of 1¾ in., affording a protection to the springs against being compressed solid. Two 6¼ in. by 8 in. M.

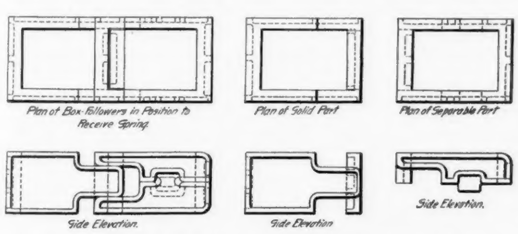


Fig. 2.—Details of Box Followers.

C. B. draft springs are used, and the only other parts are the front and rear cheek plates riveted or bolted to the sills, which are replaced by lugs on the metal draft beams when used. A tie plate supports the gear and this may be readily dropped, allowing the removal of the gear from the car when desired. This form is also used in a triple tandem spring gear made under the same patents. The parts as given in Fig. 1 are: 1, yoke; 2, solid box followers; 3, separable box followers; 4, cheek plates; 5, tie plate.

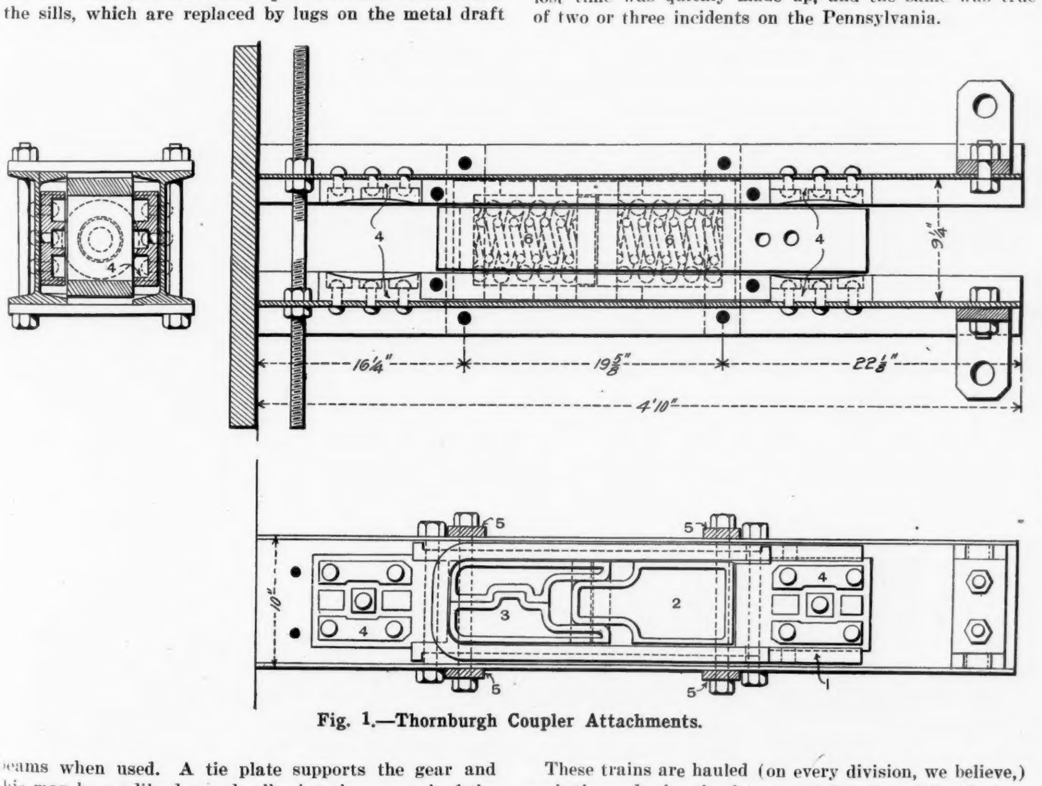
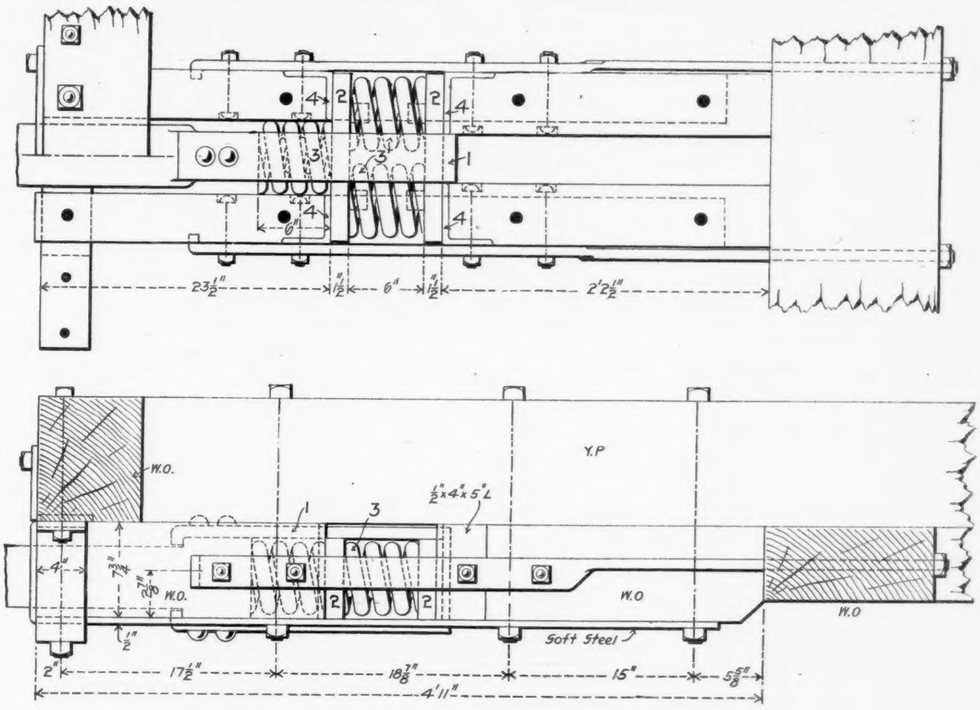


Fig. 1.—Thornburgh Coupler Attachments.

The Wright Triple Spring Draft Gear.

This draft gear which was among those tested by the M. C. B. committee at Altoona has three springs, double coil, 6 in. x 6 in., arranged in triangular shape, two side by side, and the third in front between the coupler shank and the forward follower. As shown in the drawing the whole arrangement is set below the center sills between two sub-sills which are cut away to make room for the pair of springs. The single spring is between the two sub-sills. In tension the two rear springs only are in action while in buffing all three are brought into play. Paddle bolts running back through the transom take part of the stress in tension. The parts are: 1, yoke; 2, followers; 3, draft springs; 4, angle irons protecting the sub-sills and forming follower stops.



The Wright Triple Spring Draft Gear.

The Chicago Twenty-Hour Trains.

The trains scheduled to run between New York and Chicago in 20 hours, as announced in our issue of June 6, page 414, and June 13, page 451, made their initial trips with complete success; both the eastbound and the westbound trains, on both the Pennsylvania and the New York Central reaching their respective destinations three or four minutes ahead of time. One account says that the westbound "Twentieth Century Limited" was detained 10 minutes once or twice on the Lake Shore road; but the lost time was quickly made up, and the same was true of two or three incidents on the Pennsylvania.

These trains are hauled (on every division, we believe,) on both roads, by the latest and heaviest Atlantic type locomotives. These locomotives, already in use on the other fast (and much heavier) trains of these roads, are already well-known to the readers of the *Railroad Gazette*. The new trains are advertised to consist of four cars each, but on both roads, for at least a part of the journey, five or six cars have already been taken, and, as is evident from the past performances of the locomotives used, more than four cars can doubtless be taken at any time.

The running time of the westbound train over the New York Central and the Lake Shore, as shown on the working time-tables over each division, is as follows:

Station.	Ar. or Lv.	Miles.	Time.
New York............	2:45 p. m.	142.88	2 h. 50 min.
Albany	5:35 p. m.		
Albany	5:39 p. m.	147.84	2 h. 59 min.
Syracuse	8:38 p. m.		
Syracuse	8:42 p. m.	148.80	3 h. 3 min.
Buffalo	11:45 p. m.		
Buffalo (C.T.)........	10:50 p. m.	183.00	3 h. 37 min.
Cleveland	2:27 a. m.		
Cleveland	2:30 a. m.	107.80	2 h. 15 min.
Toledo	4:45 a. m.		
Toledo	4:48 a. m.	133.40	2 h. 39 min.
Elkhart	7:27 a. m.		
Elkhart	7:30 a. m.	94.40	1 h. 57 min.
Englewood	9:27 a. m.		
Englewood	9:27 a. m.	6.70	0 h. 18 min.
Chicago	9:45 a. m.		
		964.82	19 h. 38 min.
Stops allowed for above..................			.. 22 min.
			20 h. 0 min.

Besides the stops at the terminals, as above shown, the train stops at Utica and Rochester two minutes each, at Erie three minutes, and at Englewood and at Thirty-first street, Chicago. Estimating the last two stops at one minute each the total time consumed by station stops is 31 min. Besides this there is an extra stop at Buffalo, which is made necessary by the backing of the train into the station. There are, of course, numerous other losses due to necessary slackening of speed, so that it would be hardly practicable to make any useful estimate of the average rate of speed in motion. The average time through, including stops, is as stated in our former notice; or, to include the fractions, 48.24 miles an hour. The extra stop at Buffalo and the low speed necessary in backing the train a short distance necessitates an allowance of about 10 min. The schedule which covers this movement allows 12 min. for a distance of two miles. From Girard Junction to Mentor on the Lake Shore the distance is 56 miles, and the schedule time is one hour. We have divided the miles and the time at Englewood for the reason that beyond that point the speed is necessarily low.

The time of the westbound train over the Pennsylvania is as follows:

Station.	Ar. or Lv.	Miles.	Time.
Jersey City.........	2:13 p. m.	88	1 h. 37 min.
Powelton Ave. (Phila.)	3:50 p. m.		
Powelton Ave........	3:55 p. m.	103.9	1 h. 55 min.
Harrisburg	5:50 p. m.		
Harrisburg	5:55 p. m.	131.4	2 h. 35 min.
Altoona	8:30 p. m.		
Altoona	8:35 p. m.	116.9	2 h. 30 min.
Pittsburgh	11:05 p. m.		
Pittsburgh (C.T.).....	10:10 p. m.	188.8	4 h. 18 min.
Crestline	2:28 a. m.		
Crestline	2:31 a. m.	272.6	6 h. 4 min.
Englewood	8:35 a. m.		
Englewood	8:35 a. m.	7.2	.. 20 min.
Chicago	8:55 a. m.		
		908.8	19 h. 19 min.
Stops allowed for above................			.. 23 min.
			19 h. 42 min.
New York ferry.........................			.. 18 min.
			20 h. 0 min.

The passenger stop at Philadelphia is at Germantown Junction, four miles east of Powelton avenue. At Powelton avenue, where engines are changed, the train is turned, but this will be done away with in a few weeks, when the third leg of the Mantua Y is put in shape for passenger trains. This will shorten the distance about 2½ miles. At Crestline no stop is scheduled, but as the arriving and leaving times are 3 min. apart, and it is

a division terminus we assume that engines are changed. At Fort Wayne, 131.4 miles west of Crestline, there is a similar allowance of 3 min., but the train is scheduled to stop only to let passengers off. Estimating the Germantown Junction and Englewood stops at one minute each, the total allowance for stops would be 28 min.

For the 908.8 miles from Jersey City to Chicago, traversed in 19 hrs. 42 min., including all stops, the average rate of speed is 46.1 miles an hour. The rate over the New York Division is 54.4 miles an hour; the Philadelphia Division, 54.2; Middle Division, 50.9; Pittsburgh Division, 46.8. West of Pittsburgh there is some single track and the rate from Pittsburgh to Englewood, 461.4 miles, is 44.5 miles an hour.

English Railroads and Electricity.

It is a sign of the times that several of the engineering societies in England should be devoting meetings to the consideration of the conversion of steam railroads to electrical working.

The principal event of this kind is undoubtedly the discussion which has already occupied several sittings at the Institution of Civil Engineers in London. The paper which served to introduce the subject was prepared by Messrs. Mordey and Jenkin, who endeavored to cover the whole question of the present position, especially with regard to the best electrical system to adopt. The discussion so far has been a far more valuable one than that which took place at two meetings of the Institution of Electrical Engineers in London something over a year ago. Engineering officials from some of the great trunk railroads have stated their views at one of the present series of meetings and have stated the difficulties which face them and the fact is plainer than it ever was that many years have yet to elapse before it will be found profitable to scrap millions of pounds' worth of locomotives and spend millions more upon electrical equipment for heavy railroads.

The Institution of Electrical Engineers at Manchester have also been discussing the matter, Mr. James Swinburne having opened the ball with a contribution on "The Electric Problem of Railways." Mr. Swinburne endeavored to drive home the important truth that electric railroads should not necessarily be enlarged tramways. He dwelt upon the importance of acceleration on short lines and especially at the beginning of a run.

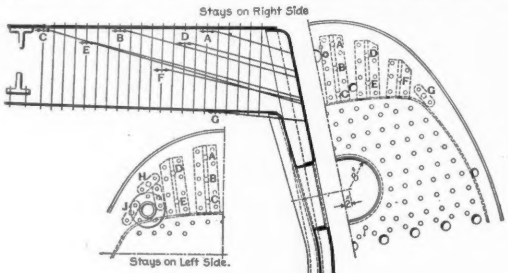
He thought it would be a calamity if railroads took up different systems of electric working, some having 500 volts, others 1,000, 2,000 or 10,000; some having constant currents, some direct and some three-phase, while others have constant pressure of each kind. Locomotives built for 500 volts are not suitable for 2,000. If the 500 volt locomotives are for tube railroads with large acceleration they can hardly be run as express locomotives, as their motors will run too fast. Standard pressures and currents were most necessary. Each railroad would then have, as at present, slow locomotives with great pull for shunting, for goods traffic and for suburban and stopping trains, and fast locomotives, with less acceleration, but higher speeds, for through traffic.

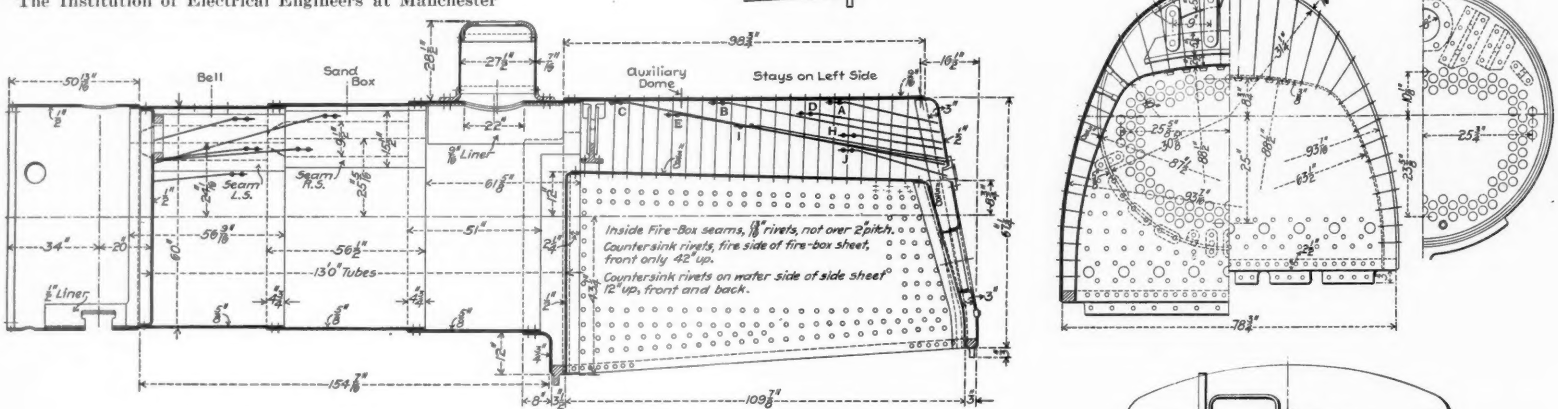
The Baker St. & Waterloo Electric Underground Railway has now definitely been taken in hand by Mr. Yerkes' company—the Metropolitan District Electric Traction Company. The purchase price is announced as £360,000, plus interest. The line is now about half built and it is expected to be finished by about the time of the completion of the great power station which is being put down at Chelsea for the working of the Metropolitan District Railway. The Baker street line will take its current from this station. B.

New Suburban Engines of the Central Railroad of New Jersey.

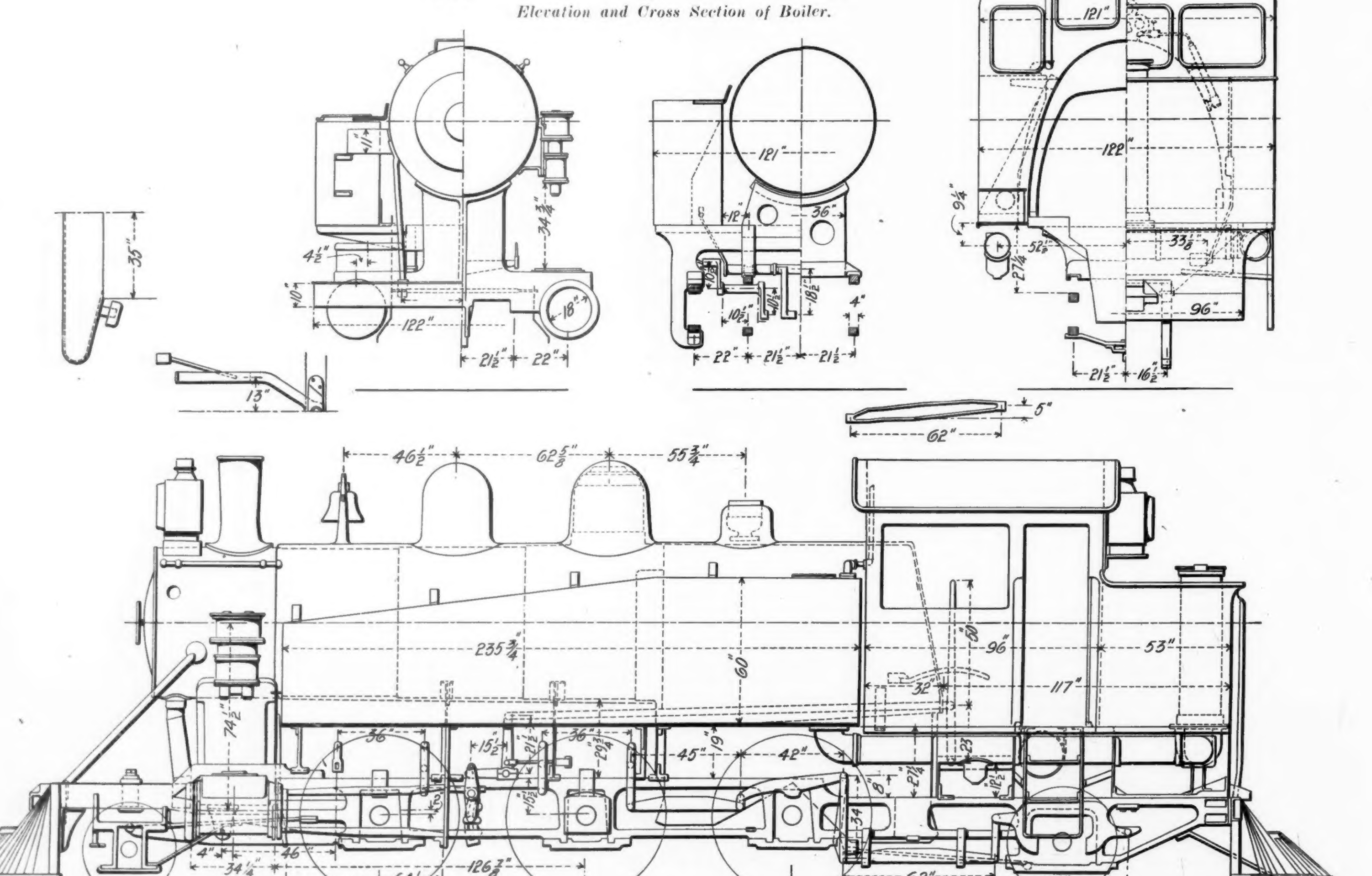
The Central Railroad of New Jersey has recently received several engines of an order of 12, for suburban service, from the Baldwin Locomotive Works. The engine illustrated here, although it carries water and fuel over its total wheel base is nevertheless a 2-6-2 or Prairie type. The engine has some interesting features and the various details have been worked out with much skill and judgment.

The total wheel base is 31-ft. 8-in. About five tons of hard coal is carried in the coal space which extends back 53 in. from the cab, and the overhang from the carrying wheels outward is 68½ in. Water is taken in on the center line of the engine, so that no alteration of water spouts or water cranes is necessary on the road. The intake pipe extends downward through the coal space to below the level of the cab floor and is joined to a large Y-pipe which communicates with the tanks which rest upon the running boards. A pocket in this Y insures perfect drainage when required, and from this lowest point in the water-carrying arrangement, the injectors draw their supply. Just in front of the look-out windows of the cab, each tank has a man-hole, which is usually bolted down tightly upon a rubber joint. An air vent pipe passes up from just beside this man-hole, turns into the cab and goes out through the roof. The cover for the intake pipe is a hinged disc which when closed makes a tight joint on the top of the pipe and is fastened down with a pair of lugs which lie on either side of a



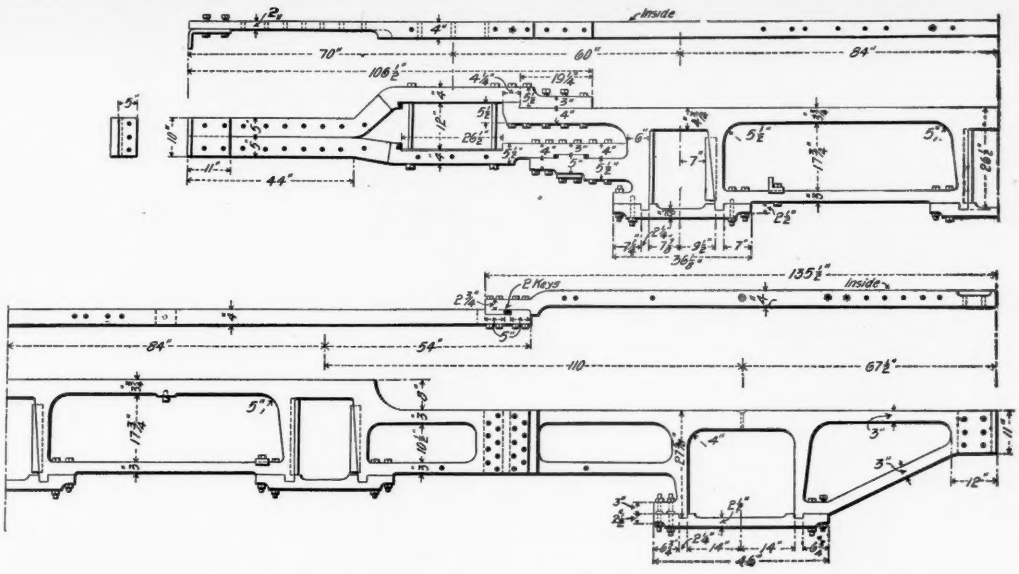


Elevation and Cross Section of Boiler.

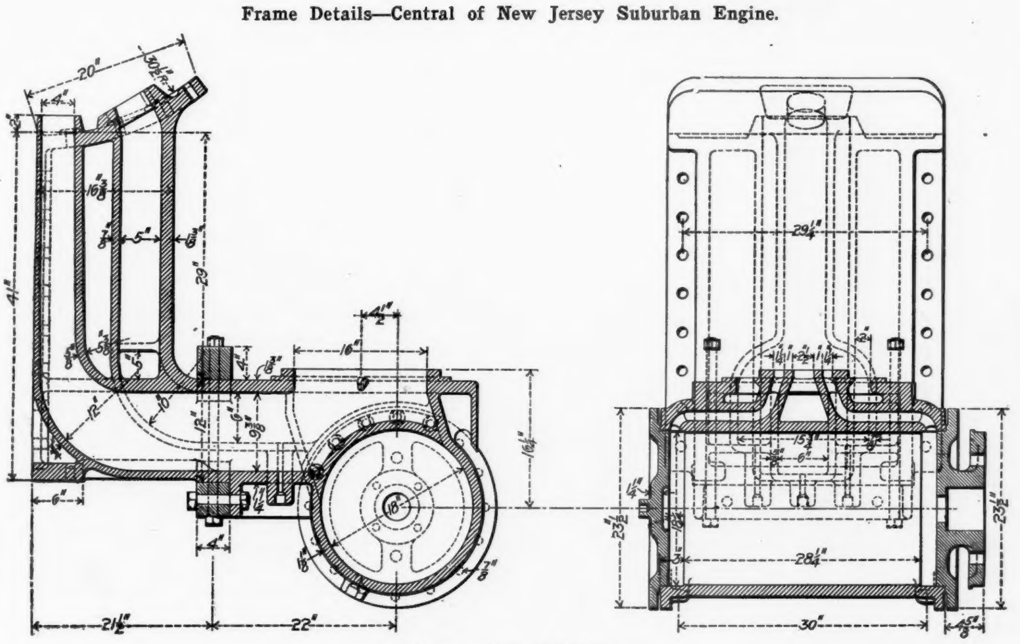


General Plan of Suburban Locomotive—Central Railroad of New Jersey.

Mr. W. McIntosh, Superintendent of Motive Power. *Built by the* Baldwin Locomotive Works, *Philadelphia.*



Frame Details—Central of New Jersey Suburban Engine.



Cylinder and Half Saddle.

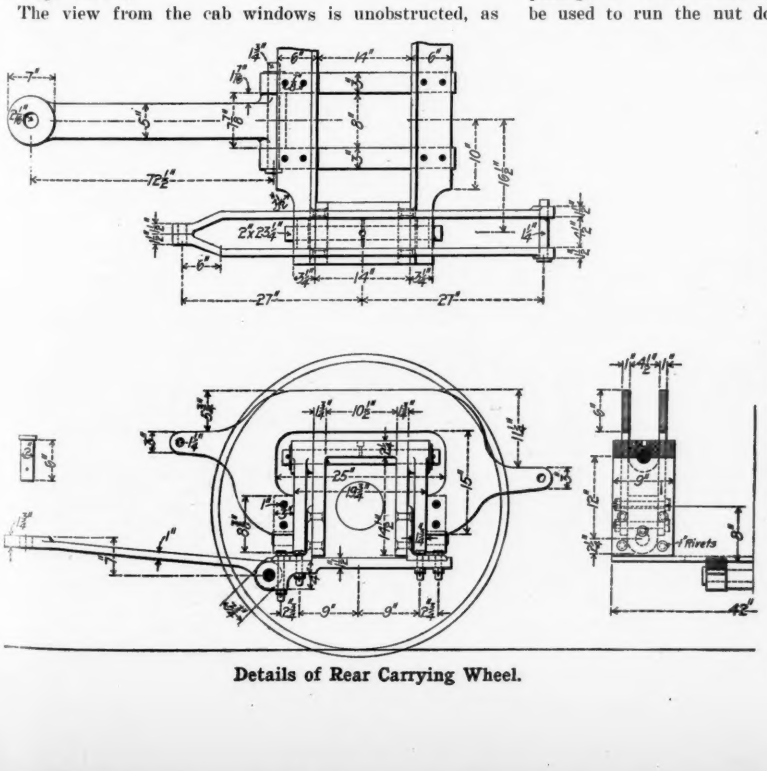
hinged bolt, with thumb-nut, exactly as a dead light is secured over a port-hole in the cabin of an ocean steamer. The tanks and pipes on the engine may thus be filled to maximum capacity, 3,000 gallons. Air having access to the surface of the water through the vent pipes the injectors can work freely. A decided advantage in the arrangement of water and coal is, that the water being carried practically in the center of the engine, the effect of the side swash of the water is reduced to a minimum and the distribution of the total supply between two tanks still further takes away from any effect the side swash might have. The coal, which does not sway on curves, is carried on the overhang of the frames, and steady, does not exert side-bending pressure on the frames. The Rushton radial truck at the rear has been given ample sideplay and guides the engine steadily round curves and by this whole arrangement the engine experiences the least possible disturbance in running fast through curves.

The view from the cab windows is unobstructed, as the tank slopes gradually toward the smoke-box, and on the left side the air-pump top is only just visible from the fireman's window. The cab is roomy and the fittings and devices have been carefully arranged with a view to general "handiness" and compactness.

The injectors are both on the right side, and both delivery pipes pass into an ingenious device called the quadruple safety boiler check. This device is really a boiler check valve and an air or hand-operated blow-off cock. Water on its way to the boiler passes in at A, unseats valve B, enters chamber C, finds valve D closed by the action of the spiral spring shown, opens check valve E and enters the boiler. When used as a blow-off cock, air introduced at F depresses piston G, compresses the spiral spring, unseats valve D, the downward movement of D, unseats check valve E, and allows water from the interior of the boiler to pass up into chamber C, when it closes valve B, and passes out to the atmosphere through passage H. If air is not available the handle on top may be used to run the nut down, to which it is attached, and so depress the piston G, with similar results.

The engine is neat and trim in appearance, the arrangement of everything from stack to rear headlight, under the eave of the cab roof, suggests compactness. The cylinders are 18 x 26-in. and the steam pressure is 200 lbs. American balanced valves are used. The total tractive effort of the engine is 22,800 lbs. Taking off 10 per cent. for internal friction, etc., the net tractive force stands at 20,520 lbs.

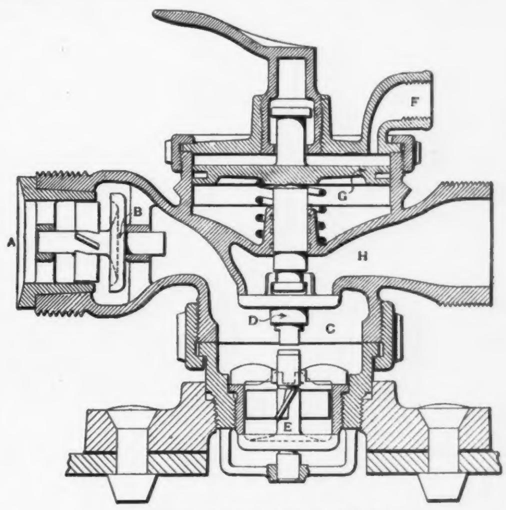
A guide-bar oil cup with an "unloosable and un-stealable" cover is an attachment which cannot but attract attention among those whose business makes them familiar with roundhouse ethics. In addition to the fact that the cover won't come off, the adjustment of the stationary needle is admirable. The spring which holds the cover down, reacts upward on the nut by which the needle is turned and by adding friction helps to hold the stem just where it has been placed. In the lower part of the cup, where a cross passage has been cut in the central pillar, the hole for the stem is bored $^{4}/_{1000}$ of an in. less than the diameter of the needle, which at that place is $^{11}/_{32}$-in. The result is that when the needle is in place it is pinched sufficiently to prevent it jarring round in one direction or the other, so that an exceedingly minute oil opening may be secured at will. The oil from these cups is led to the edges of the guide bars, not to the center of the underside as is usual. Two oil cups are placed on each guide, and this arrangement prevents oil from the back cup dropping uselessly on the top of connecting rod when the piston is at the forward end of the cylinder. This arrangement puts oil where it will always be used, and not spattered about over the motion. Reference to the drawing will show how by lifting up the cup-cover by finger and thumb, thereby compressing the spring sufficiently to allow the four little bosses on the underside to clear, the cover may be turned round and two ample openings disclosed.



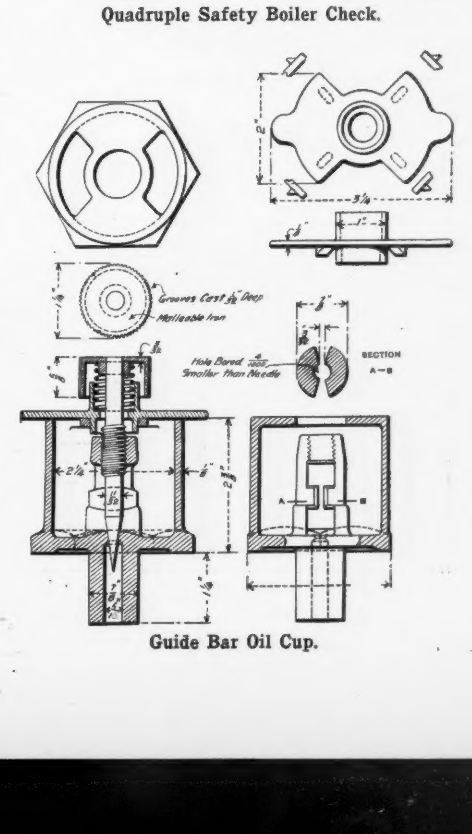
Details of Rear Carrying Wheel.

Very satisfactory service has been had with these engines, pulling 10 or 12 coaches, on their "start and stop" runs, at good average speeds. The popular idea of the ordinary "suburbanite," that a railroad always uses engines on *his* trains, which won't make time with expresses, must give way before the up-to-date machines which have been put to work on this exacting service on the Central Railroad of New Jersey. A few of the principal dimensions are given below:

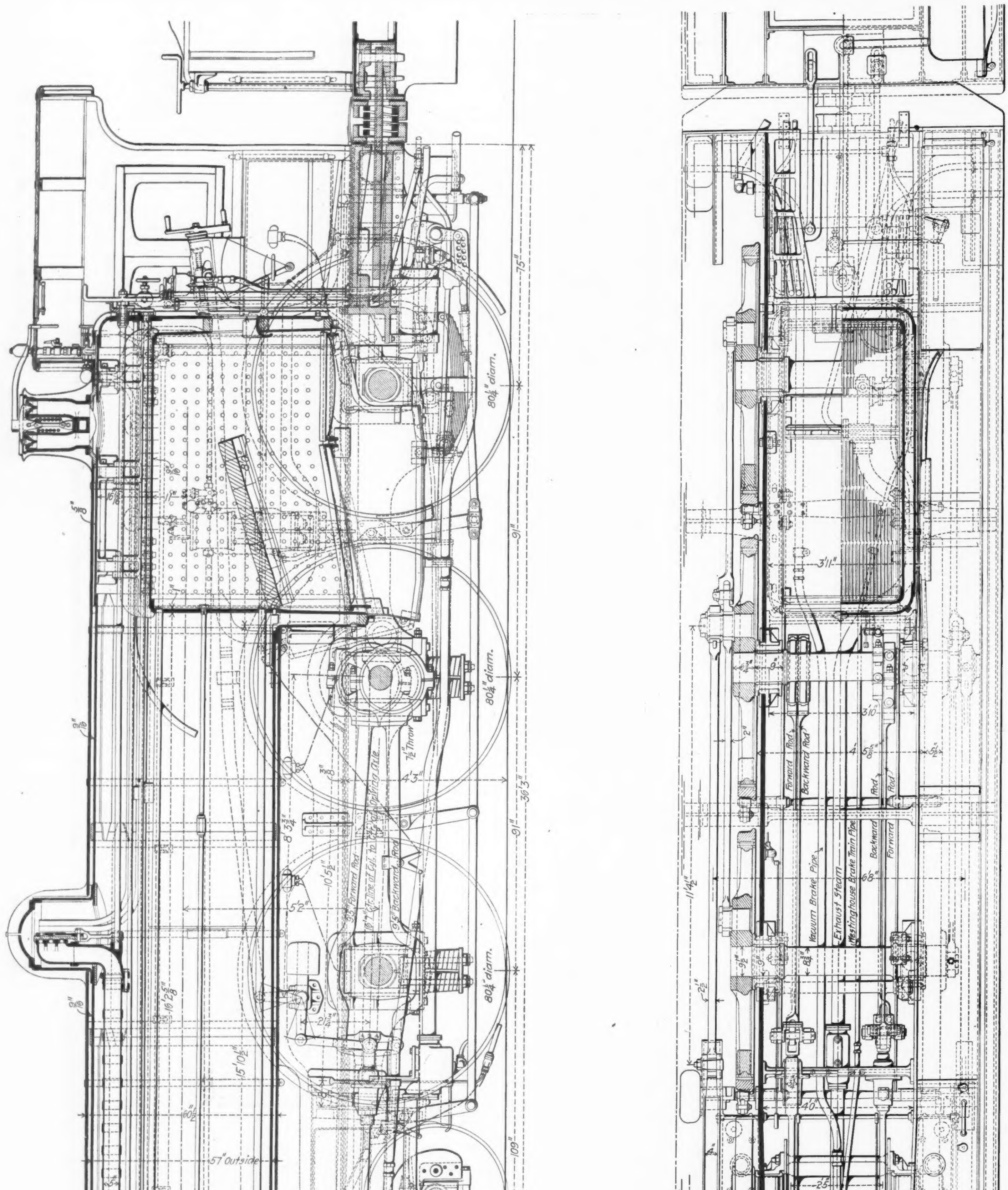
Gage	4 ft. 8½ in.
Cylinder	18 x 26 in.
Valve	American balanced
Boiler, type	Straight
Boiler, diameter	60 in.
Boiler, thickness of sheets	⅝ in.
Boiler, working pressure	200 lbs.
Boiler, fuel	Hard coal
Boiler, staying	Radial
Fire-box, material	Steel
Fire-box, length	109 in.; width, 72 in.
Fire-box, depth	Front, 55¼ in.; back, 44¾ in.
Fire-box, thickness of sheets	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.
Fire-box, water space	Front, 3½ in.; sides, 3 in.; back, 3 in.
Tubes, material	Iron, wire gage No. 12
Tubes, number	249; diameter, 2 in.; length, 13 ft. 0 in.
Heating surface, fire-box	137.4 sq. ft.
Heating surface, tubes	1,695 sq. ft.
Heating surface, total	1,832.4 sq. ft.
Grate area	54.5 sq. ft.
Driving wheels, diameter outside	63 in.
Driving wheels, diameter of center	56 in.
Driving wheels, journal	Main, 8½ x 12 in.; others, 8 x 12 in.
Engine truck wheels (front), diameter	36 in.
Engine truck wheels (front), journals	7 x 12 in.
Engine truck wheels (back), diameter	42 in.
Engine truck wheels (back), journals	7 x 12 in.
Wheel base, driving	14 ft. 0 in.
Wheel base, total engine	31 ft. 8 in.
Weight on driving wheels, with half supply of coal and water	108,000 lbs.
Weight, total engine and tender	165,000 lbs.
Tank capacity	3,000 gals.
Service	Suburban



Quadruple Safety Boiler Check.



Guide Bar Oil Cup.



The Ten-Wheel Express Engines of the North-Eastern Railway (England).

Mr. WILSON WORSDELL, *Locomotive, Carriage and Wagon Superintendent.*

Ten-Wheel Engines on the North-Eastern Railway of England.

Some time ago Mr. Wilson Worsdell designed several 10-wheel engines for the North-Eastern Railway, and one of them was on view at the Paris Exposition. Since then the design has been somewhat improved, and the driving wheels, which in the first engines were 73 in. in diameter, have now been raised to 80¼ in. The engines are intended to haul express trains of from 350 to 375 tons at an average speed of 53 miles an hour. They have been put on the Scotch express between York and Edinburgh, and are therefore expected to take their share of the heavy passenger traffic of the East Coast Line.

The road over which they run from Edinburgh southward has grades chiefly in the first 20 miles, which practically give a steady pull from the start. The most difficult grade on the section is 1 in 96 (55 ft. per mile), which is about five miles long, the others run 1 in 150 (35 ft. per mile), 1 in 170 (31 ft. per mile), and 1 in 200 (26 ft. per mile). The East Coast distance between York and Edinburgh is 124 miles.

The average performance of these engines is good, though from data before us, the train weight on several trips noted, was not within 100 tons of what the engines are expected to haul. On the first of these trips, average speed was reduced by numerous slow downs, and the 1 in 96 grade was climbed with a finishing speed of 25 miles an hour, the engine hauling 275 tons. The run from Newcastle to York, a distance of 80.6 miles, was accomplished satisfactorily enough to demonstrate the value of the class.

On a second trip made in the same direction, the lowest speed on the heavy grade was 50 miles an hour with the same load as formerly. A slow down for the viaduct at Durham reduced the speed to 30 miles an hour, but it rose to 53, before the summit of Ferry Hill grade was reached. An average speed of 58.2 miles an hour was maintained from start to stop, while the level 44¼ miles separating Darlington from York, was run in 41 minutes 11 seconds.

On the third trip, made northward, the train weighed 210 tons. A stop was made at Berwick, where the position of the station is such that a train stands on three curves at the same time, with a 1 in 200 grade to be faced. A speed of 42 miles an hour was made before the top of the grade was reached, and the 1 in 96 grade being down hill on this occasion the last three-quarters of a mile was covered in 38 seconds.

The performance of these engines appears to have been made with light throttle and late cut-off, the engine drivers no doubt believing that "to work expansively is to work expensively."

This road was the first to introduce the 10-wheel type into Great Britain, for passenger service, and the good work done by these engines supports Mr. Worsdel's judgment. Considering the size of the boiler and the amount of heating surface, which is 1,769 sq. ft., with 23 sq. ft. of grate area, and taking into consideration the large cylinders which these engines have, the work done by them is fine. They certainly steam freely.

A few of the leading dimensions are given below:

Cylinders, Etc.	
Diameter of cylinders	20 in.
Stroke of piston	26 in.
Diameter of piston valve	8¾ in.
Lap of valve	1⅛ in.
Lead of valve	⅛ in.
Maximum travel of valve	$4^{21}/_{32}$ in.
Diameter of piston rod	4 in.
Length of connecting rod (centers)	11 ft. 4½ in.
Wheels and Axles.	
Driving wheel diameters	6 ft. 8¼ in.
Diameter of bogie wheels	3 ft. 7¼ in.
Driving journals (steel)	9 x 9 in.
Bogie journals (steel)	6 x 9 in.
Crank Pins (Steel).	
For connecting rods (driving wheel)	6 x 5 in.
For coupling rods (driving wheel)	6¾ x 3½ in.
For coupling rods (leading and trailing wheels)	5¼ x 3 in.
Frames (Steel Plate).	
Thickness	1 in.
Boiler.	
Working pressure	200 lbs.
Center of boiler from rail	8 ft. 6 in.
Length of barrel	15 ft. 10½ in.
Outside diameter	4 ft. 9 in.
Thickness of plates	$^{9}/_{16}$ in.
Fire-box Casing (Steel).	
Length outside	8 ft. 0 in.
Breadth outside bottom	3 ft. 11 in.
Thickness of plates	⅝ in.
Distance apart, of copper stays	4 in.
Diameter of copper stays	1⅛ in.
Fire-box, Inside (Copper).	
Length at bottom inside	7 ft. 3½ in.
Breadth at bottom inside	3 ft. 2⅝ in.
Depth of box inside at front	5 ft. 8 in.
Depth of box inside at back	4 ft. 8 in.
Tubes (Steel).	
Number of tubes	193
Length between plates	16 ft. 2⅝ in.
Outside diameter	2 in.
Thickness	No. 12 W. G.
Heating surface of tubes	1,639 sq. ft.
Heating surface in fire-box	130 sq. ft.
Total	1,769 sq. ft.
Miscellaneous.	
Grate area	23 sq. ft.
Height of chimney above rail	13 ft. 1 in.
Weight of Engine in Working Order.	
On bogie wheels	33,936 lbs.
On leading wheels	34,384 lbs.
On driving wheels	43,680 lbs.
On trailing wheels	38,304 lbs.
Total	150,304 lbs.
Weight of Tender in Working Order.	
On front wheels	29,120 lbs.
On center wheels	28,000 lbs.
On trailing wheels	34,944 lbs.
Total	92,064 lbs.
Tender Wheels and Axles.	
Diameter of tender wheels	3 ft. 9¼ in.
Tender axle journals	5 x 10 in.
Capacity of tank	3,375 gals.
Capacity of well	565 gals.
Total capacity	3,940 gals.
Capacity of coal space	5 tons
Tender fitted with water scoop.	

The Roanoke Shops of the Norfolk & Western.

The shops of the Norfolk & Western at Roanoke, Va., have for many years been among the most prominent in the South, not only for the excellence of the work done, but for the progressiveness of the officers in charge. The 80,000 lbs. capacity box car with a steel upperframe and the consolidation Class W locomotive that have been recently illustrated in these columns are examples of the output of these works.

While the shops have ranked well in the railroad world, the growth of traffic has rendered them inadequate to the demands. The result is that extensive improvements, involving a complete change in the power plant, have recently been made.

The engraving shows a plan of the shops as they have been remodeled. The most important element in the changes made is the installation of a new power plant. This involved an entire remodeling of the old one, without interruption of the work. As in all shops that have grown from smaller things, engines and boilers were scattered over the premises for the work of the several departments, being entirely independent of each other, and no one of them occupying quarters commodious enough to be converted into a central plant. The only thing that was large enough was a brick stack standing at the western end of the machine shop.

The first thing done, then, was to build a brick boiler house west of the blacksmith shop and place therein three Babcock & Wilcox water-tube boilers of 200 h.p. each. These are connected by an overhead breeching with the stack. The boiler house is large enough to permit of the placing of two more boilers of the same size, so that eventually this part of the plant will be capable of supplying steam for 1,000 h.p.

The house is fitted with a trench, in which an ash car travels for the removal of the ashes, while on the north side there is a trestle from which the fuel may be unloaded at a point involving the minimum amount of labor in handling.

The whole western end of the machine shop building has been devoted to an engine and dynamo room.

The shops were already equipped with some electric lighting machinery, but when the new plant is completed it will furnish power on the group system for the various shops. In the power room there will be one 75-kilowatt and two 160-kilowatt direct-connected generators, driven by vertical compound non-condensing Buckeye automatic engines. The distribution of the current so generated will be through a 10-panel switchboard, divided as follows: One for each generator, one for a balancer set, one totalizing panel, two for power circuits and two for lighting circuits. The system will be worked under a direct current of 220 volts, using the two-wire plan for power and the three-wire for the lighting circuits.

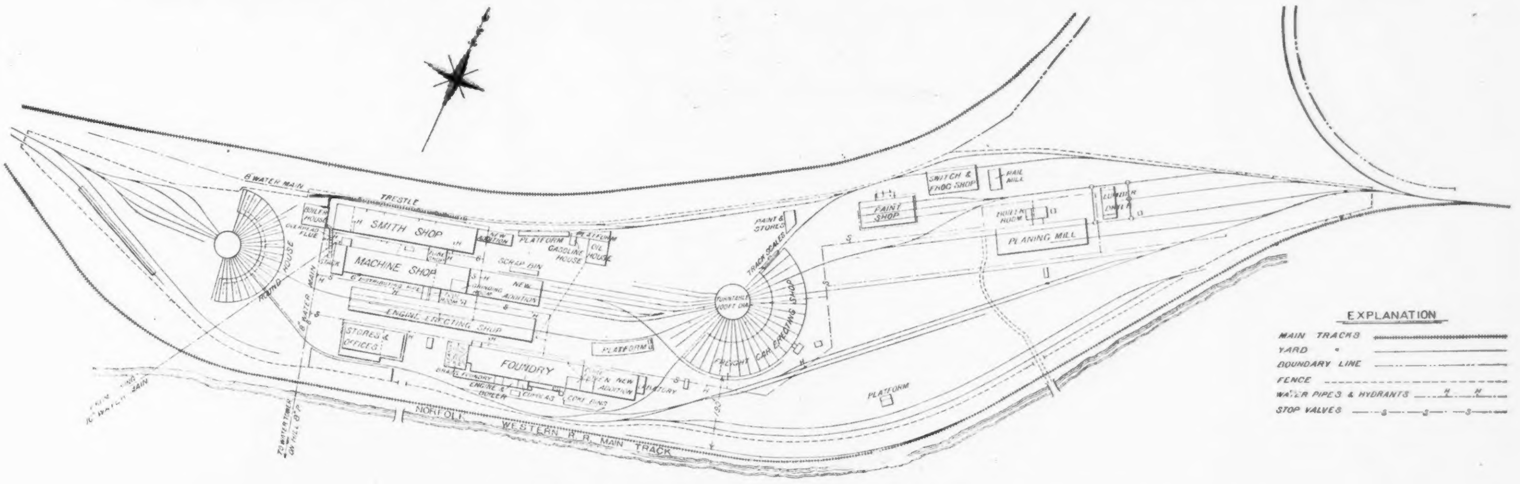
As already stated the machinery is to be grouped and each group driven by a common motor rather than by the individual method. To meet the requirements of the shop the following motors have been ordered: three of 7½ h.p., five of 10 h.p., three of 15 h.p., 10 of 20 h.p., one of 30 h.p. and one of 35 h.p., making 382.5 h.p. in all or well below the rated capacity of the boiler house even allowing for the drop between the engine and motor. Of these motors two of the 20 h.p. are extras, for which no position has yet been assigned. The main lighting will be done by 100 arc lamps, with a 110-volt current, and on the same circuit as the incandescent lamps used for individual lighting.

The power thus developed will be used for all classes of work in the machine shop, though not to the exclusion of compressed air for the hoists.

As the shops stand their arrangement is convenient. The engine house stands at the western end of the yard, near the outlet to the main line and facing the station, which is not shown on the plan. It is close to the smith and machine shops, so that roundhouse repairs may be made with but little time or labor involved in transferring materials. The smith, machine and erecting shops stand side by side, with the foundry close at hand. Of these, three have been recently enlarged by the construction of a new addition, as shown, and the capacity of the traveling crane in the machine shop has been increased from 25 to 40 tons.

The car department occupies a separate section of the grounds using a large 21-stall roundhouse, with a 100-ft. turntable, driven by a pair of vertical steam engines, for an erecting and general repair house. There is nothing of peculiar interest about these buildings other than the possession of a number of shop conveniences, which will be taken up somewhat in detail in a future article.

There is, however, one contemplated addition to these works, not shown in the plan, which is of the first importance as marking the new era in car construction upon which we may be said to have entered. This is the erection of a shop devoted to the repairing of steel cars.



The Roanoke Shops of the Norfolk & Western Railway.

The details of this building have not yet been decided upon, but it is expected that it will be of ample size for the work to be done and be equipped with special machinery for the peculiar class of repairs that will there be undertaken. At present the burden of these repairs falls upon the boiler shop, thus making that department the weak link in the capacity of the shop considered as a whole. With the contemplated department for repairing steel cars, the boiler shop will be relieved of a great deal of work which it is not equipped to handle, and its resources can be turned to its legitimate functions, thus increasing the monthly output, while the steel cars will be handled more economically and expeditiously.

Allusion has been made to the increase of traffic and equipment on the Norfolk & Western in recent years. As an example of what is being done the following orders were recently in course of execution or about to be placed: The shops were about completing an order for 400 wooden frame box cars of 80,000 lbs. capacity, and 1,000 others had been contracted for. The following shop order will be for 100 box cars of 80,000 lbs. capacity, with steel upper and underframing, like the one illustrated in the *Railroad Gazette* on April 18. The shops also have orders for 500 flat-bottom, hopper gondolas of 80,000 lbs. capacity, and a number of combined baggage and mail and baggage and express cars 60 ft. long. In addition to these cars contracts have been placed for 2,000 flat-bottom drop-door gondolas of 80,000 lbs. capacity and 750 hopper gondolas of 80,000 lbs. capacity, similar to the 100,000 lbs. capacity cars, having center doors, but with one set of doors omitted. Tenders have also been asked for 500 flat cars of 80,000 lbs. capacity and 40 ft. long. The road either is or will be in the market soon for a number of passenger coaches and chair cars.

In the locomotive department contracts have been placed for 40 Class W consolidation locomotives, with 21-in. x 30-in. cylinders, like that illustrated in the *Railroad Gazette* of April 25, in addition to the one per

month that is being built at the shops. From these few figures it will be seen that the shops and the road are sustaining their reputation for progressiveness, and when the new plans have been fully executed the efficiency of the plant will be greatly increased. The present changes have been planned by Mr. C. A. Seley, recently the Mechanical Engineer (now Mechanical Engineer, Chicago, Rock Island & Pacific), under the direction of Mr. W. H. Lewis, the Superintendent of Motive Power, through whose courtesy the accompanying drawing and data have been furnished.

The Largest Shay Locomotive Ever Built.

The accompanying photograph illustrates a new Shay patent geared locomotive, recently built by the Lima Locomotive & Machine Company for the El Paso Rock Island Route.

A comparison between the recent heavy locomotives built by the Schenectady Works of the American Locomotive Company for the Atchison, Topeka & Santa Fe, which have a weight on drivers of 237,800 lbs., and the Shay locomotive, which has a weight on drivers of 291,000 lbs. in working order, shows that the Shay locomotive has more weight on drivers than the heaviest direct connected engine built up to the present time. It must be borne in mind, however, that the Shay engine utilizes for tractive effort the weight of the tender and its contents. This tender weight is variable, ranging from 130,000 lbs. down to practically the light weight of the tender, depending on the length of run. In the case of this locomotive the separate tender becomes a car with auxiliary motive power derived from the engine, the tractive effort of which is, as we have said, a variable.

The engine and tender are carried on four center-bearing swiveled trucks with four wheels to each truck, or a total of 16 wheels, with a wheel base of 57 ft. 4 in. about 16,000 lbs. each, and a caboose weighing 12,000 lbs., or net weight of 222 tons, with engine, 362 tons, was taken over the 6½ per cent. grade. This haulage is equivalent to 715 tons total, or 575 tons net train weight on 3 per cent. grade.

The fact that the engine works on a division of continuous grades for 25 miles requires it to have ample boiler power and in supplying this together with a large water carrying capacity, a heavier engine resulted than was needed to provide for the necessary adhesion for the tractive power developed. The general dimensions of the engine are given below:

General.

Gage of road	4 ft. 8½ in.
Fuel used	Soft coal
Water capacity of tender	6,000 gals.
Coal capacity, coal bunk	9 tons
Working steam pressure	190 lbs.
Total wheel base, engine and tender	57 ft. 4 in.
Total length, engine and tender	71 ft. 9 in.
Height rail to top of pop valves (clearance height),	14 ft. 10 in.
Weight on drivers in working order	291,000 lbs.
Total weight in working order	291,000 lbs.
Weight of tender, empty	62,500 lbs.

Wheels, Etc.

Number of trucks	4
Rigid wheel base of trucks	58 in.
Number of driving wheels	16
Diameter of driving wheels	40 in.
Number of teeth in gear rims	41
Number of teeth in pinions	20
Pitch of teeth	2¼ in.
Face of teeth	7 in.
Material of gears	Cast steel

Cylinders, Etc.

Cylinders, number	3
Cylinders, dimensions	15 in. dia. x 17 in. stroke
Valves, kind	Lima Balanced
Crank shaft, material	Forged steel
Cranks	Set at 120 deg. angles

Boiler.

Type	Extended wagon top
Diameter of boiler at smallest ring	60 in.
Thickness of barrel plate	⅝ in. and ¾ in.
Thickness of tube sheets	½ in.
Horizontal seams	Butt joint, inside and outside welt, sextuple riveted
Circumferential seams	Double riveted
Exhaust nozzle	Single, permanent
Exhaust nozzle, diameter	5 in.
Smoke stack, tapered, least diameter	19 in.

Fire-box.

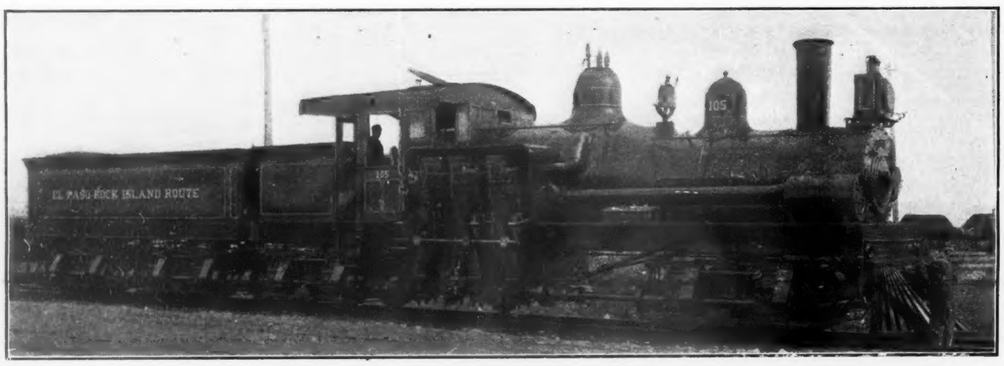
Type	Sloping, radial stay
Length inside	96 in.
Width inside	54 in.
Depth at front above grates	60 in.
Depth at rear above grates	55½ in.
Thickness crown sheet	⅜ in.
Thickness side and door sheets	$^5/_{16}$ in.
Diameter of crown stays	1⅛ in.
Diameter of staybolts	1 in.
Water space, front	4 in.
Water space, sides	3 in. to 5 in.
Water space, rear	3 in. to 4 in.

Tubes, Etc.

Tubes, number	270, 2 in. dia.
Tubes, length over tube sheets	13 ft.
Heating surface, tubes	1,837 sq. ft.
Heating surface, fire-box	156 sq. ft.
Heating surface, total	1,993 sq. ft.
Ratio, tubes heating surface to fire-box heating surface,	1:11 .77

Miscellaneous.

Sanders	Leach
Brakes, engine	Le Chatelier and steam
Brakes, train	Westinghouse Air Brake
Injectors	2 No. 8 Freidman non-lifting
Lubricator	Michigan triple sight-feed
Pop valves	Crosby
Couplers	Tower
Lagging	Magnesia
Flexible staybolts	Johnstone



Shay Patent Geared Locomotive—El Paso Rock Island Route.

Two of these trucks are under the tender, one back of the fire-box and cylinders, and one forward under the smoke-box. This distribution gives an average axle load of 36,375 lbs. and enables the engine to be used on a lighter rail and sharper curves than direct-connected locomotives of equal power and rigid wheel base. The long wheel base of this locomotive does not interfere with curving since the trucks with a rigid wheel base of but 58 in. are free to swing independently of the engine frame; the engine taking curves with 100 ft. minimum radius without producing destructive stresses on track or giving undue flange wear on tires.

The engines are self-contained and cast in one piece. They are secured to the boiler through the medium of cast-iron brackets with suitable steam and exhaust passages at the top or cylinder end, and a cast-iron bed casting at the bottom or crank shaft end, provision being made for vertical expansion of the fire-box. The exhaust pipe is carried outside the boiler and enters the smoke-box just behind the main reservoir mounted on top of the side frames. The power is conveyed from engines to driving wheels by a crank shaft and a horizontal shaft, each section being provided with universal joint and expansion couplings, forming a shaft which is rigid in rotation but flexible in all other directions.

The frames consist of heavy 18-in. eye-beams with bolsters of heavy channel iron riveted to the side frame by steel angles, the whole frame being tied together in a substantial manner. The boiler is secured to the frame by heavy cast-iron pads held to the frame by cast-steel clamp pads on the frame at the fire-box; the front end of the boiler resting on the saddle over the front bolster. Linear expansion of the boiler is provided for by a smoke-box and frame brace which is free to oscillate.

To insure absolute safety in descending heavy grades with a loaded train, a steam brake operating on all driving wheels has been provided for the engine, the engineer's valve being arranged so that brakes may be applied to engine and tender separately or together. Westinghouse air-brakes have also been provided for train service only. The engine is equipped with Le Chatelier water-brakes to relieve tires from excessive heating by continuous application of brakes.

This locomotive was designed to provide a machine that could be economically operated on the division laid with 60-lb. rail, extending from Alamogordo, N. Mex., to Cox Canon, 31 miles, with a total elevation between terminals of nearly 6,000 ft. The grades range from 3 per cent. to a little over 6½ per cent., the latter grade being near the summit of the division. There is one stretch of 4.5 per cent. to 5.2 per cent. grade, eight miles long with about one-half mile of 6 per cent. grade on heavy curves. A train of 27 empty logging cars weighing

Pulverized Fuel for Power Plants.

F. G. GASCHE, M.E.*

That the physical condition of a fuel as it is delivered to a power plant determines in a measure the ultimate efficiency of the boilers and furnaces combined, few will contest. The fact that the distribution of the foreign matter is, as a rule, far from uniform, introduces many obstructions to the attainment of desired furnace conditions. Irregular thickness of the fuel bed on the grates, patches of non-combustible offering variable resistance to in-rushing air currents, clogging of grates and other effects lead to the two serious impediments in boiler economies, viz., excess of air in the furnace, and low temperatures. Many of the steam coals available in the Middle West contain from 18 per cent. to 25 per cent. of foreign matter. Moisture is frequently present to an extent of 15 per cent. and more of the commercial weights entering the charges to the power plant. Up to certain limits a benefit is derived from preliminary crushing and the partial mixing incident to more frequent handling. One of the limits to this treatment of the fuel supply is the size of openings in the grate bars and the amount of combustible in the finely divided form that can escape to the ash pit. The best of grates and hand-firing permit combustible to escape to the extent of 15 per cent. of the total refuse, while indifferent hand-firing has frequently exhibited refuse having 45 per cent. of combustible matter lost in this manner. Mechanical stokers have been known to show refuse having 40 per cent. of combustible matter. Whatever plan may yet develop to meet these difficulties, it is safe to say that further reduction of the coal sizes will be impracticable if the fuel bed is to be supported on grates subject to more or less movement.

If we conclude that the ultimate object of mechanical reduction of coal is to produce uniformity of chemical and physical characteristics, and, above all, so to multiply the surfaces exposed to the air that rapid combustion with high furnace temperatures is made available, it is natural to inquire, Why not go to the limit, by pulverizing the fuel, and thus realize all the advantages which it undoubtedly possesses? The answer is, briefly and comprehensively, the cost of the process has been heretofore prohibitive. Although dust fuel is by no means a new proposition, many of the problems peculiar to its application have not yet been met by adequate solutions and numerous difficulties still confront the engineer who desires to employ this form of fuel. However, the present state of the art exhibits substantial progress and creditable results when measured by the statements of the cost sheets.

Since August, 1900, the writer has had opportunity for studying the possibilities of pulverized coal in various applications, including firing steam boilers, burning of cement cinder, and in various forms of heating furnaces. In view of the fact that the investigations and experimental data, although already quite extensive, are not completed, there will be no attempt to give the corroborative data for all of the several assertions that may be ventured, reserving that duty for a more complete statement of the case at a future date. There is sufficient misinformation abroad concerning boiler and furnace performance to warrant emphasis being placed on the fact that the true measure of their combined useful effect, that is their combined efficiency, is a ratio represented by a fraction. The numerator of the fraction is the numerical expression for the amount of heat absorbed through the agency of the boiler, while the denominator is the numerical expression for the total heat available in the fuel, if subject to complete and perfect combustion. Theoretically, inferior lignites ought to be applied to steam boilers with the same efficiency as a high grade bituminous coal. It is a known fact that the use of low grade western fuels is attended by lower combined efficiencies of furnace and boiler than experience with better grades of fuels would indicate as a possibility.

Assuming, for reasons given above, that the steam user does not get the worth of his money when using low grade fuels, it is conceivable that an opportunity for improved conditions might lie in the application of dust fuel, with the apparatus, furnace construction and manipulation appropriate to its use. Among the advantages of this method may be enumerated: First, a uniformity in rate of delivery and sensitiveness to control equaled only by fuel oil; second, absolute smokelessness of furnace after the latter is heated; third, a nearer approach to the theoretical limitations of air delivery than any other manner of burning fuel has exhibited in practical applications; fourth, higher furnace temperatures than other processes of support and combustion of fuel will permit because of the cooling effect of grate bars and air currents common to the usual furnace construction.

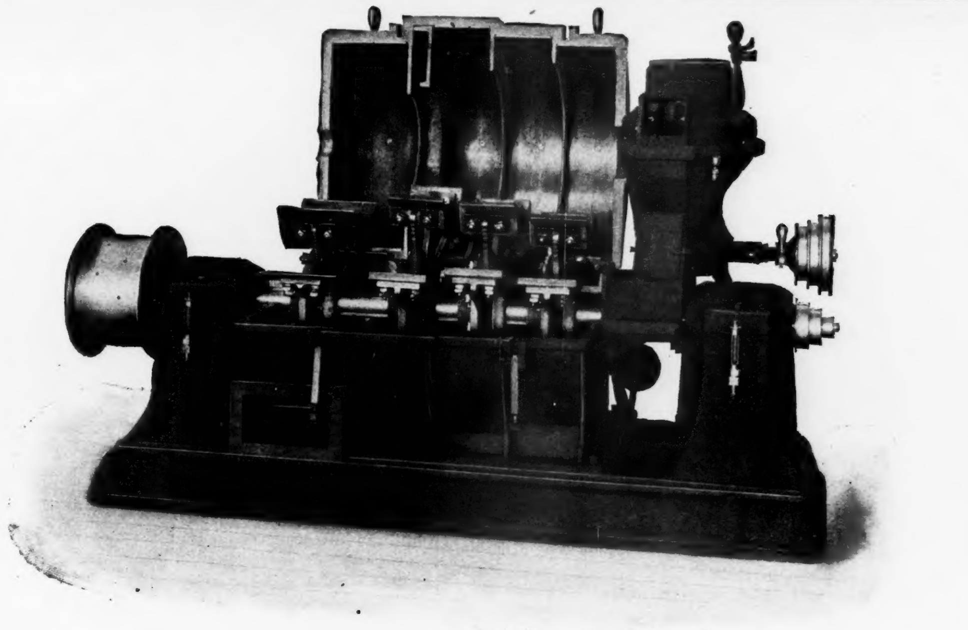
For purposes of illustration the experimental results exhibited in the accompanying tables have been abstracted from the mass of data in hand, showing merely results that have been observed and not the practicable possibilities, to say nothing of ultimately attainable effects. These tests have been selected for comparison because the rate of steam delivery was nearly the same.

The fuel (Kellyville screenings) was delivered to a machine known as the Aero pulverizer in sizes not exceeding 1¾-in. cubes. A rapid reduction to dust particles occurred, the largest of which would pass through a screen having 80 squares to the linear inch. The boiler was of the ordinary horizontal tubular type, 72 in. in diameter and 20 ft. long, having 50 4½ in. flues. The aggregate heating surface was 1,350 sq. ft.

The Aero pulverizer is made up of four compartments, the last of which serves as a fan chamber for inducing a flow of air through the machine. This flow of air serves to keep the other compartments free from coal, acts as a carrier of the dust on its way to the furnace, and as the supporter of combustion. The other three leading compartments, of varying diameter, have beaters arranged radially from a common shaft so as nearly to fill the boundaries of their respective chambers. A high speed of the shaft causes a rapid reduction of the coal by attrition. The air delivery is subject to the most delicate control that the requirements of the furnace or the pleasure of the attendant may dictate.

In studying these experimental and derived results it is well to observe, first, that the efficiency of 71.8 per cent. of boiler and furnace could have been improved if special efforts had been made to avoid air leakage into the setting and connections. Under ideal conditions of draft and air supply an ultimate efficiency of 80 per cent. is available. With more favorable conditions than those under which these trials were made an efficiency of 78.24 per cent. has been realized. Second, an efficiency of 52.2 per cent. for hand-firing is not unusually low, with the common conditions of boilers, furnaces and appurtenances. An efficiency of from 42 to 45 per cent.

*Mechanical Engineer of the Illinois Steel Co.



The Aero-Pulverizer, for Powdering Coal.

will be found a very frequent result with low grade western fuels when the balance sheet statement of test results is attempted.

A dilution coefficient of 1.98 for the hand-firing is evidence that with reasonable care in the manipulation of the furnace there is a great excess of air accounted for in the waste gases. The coefficient of 1.66 shows a creditable improvement by use of the coal dust, and it is attained largely by elimination of grate losses and the periodic opening of fire-doors.

It is known by anemometer measurements of the air entering the pulverizer that this constituted about 50 per cent. of the total theoretical requirements of the coal. The remaining air entering the furnace was almost entirely a leakage at furnace fronts and other parts of the setting. Cases have occurred in certain types of heating furnaces where air leakage was practically eliminated when 95 per cent. of the air required by the fuel entered the furnace with the dust. Analysis of the waste gases showed a dilution coefficient of 1.1, or 10 per cent. more air than the theoretical requirements.

Under such circumstances an intensely hot flame is produced, such that in the presence of an alkaline ash in the fuel there is a rapid fusing of fire-brick furnace linings as usually constructed. The flame is rarely over 10 ft. long when the moisture in the coal does not exceed 10 per cent., and the dust particles are not larger than the "80-mesh." If the moisture exceeds 15 per cent. the heat loss from its evaporation becomes important while the length of chamber necessary to provide for the retarded ignition of the dust becomes prohibitive in most boiler applications. In such cases a preliminary drying of the fuel is imperative.

The pressure of the air in the delivery pipe rarely exceeds ¼ in. of water column. The work in the fan chamber is confined largely to producing the requisite velocity of air through the machine. This is undoubtedly a small percentage of the total power absorbed by attrition of the particles of coal. The improved "two-bearing" types of pulverizer will require approximately one horse-power for every 62 lbs. of dust fuel delivered from the machine. Assuming the rather excessive costs of power delivered by an attached electric motor at 5 lbs. of coal per hour, with an illustrative coal cost of $1.70 per ton, it is seen that the cost of pulverizing and delivering one ton of pulverized fuel to the furnace is $0.137. This it is believed is a lower figure than has yet been attained when starting with 1¾-in. cubes and ending with "80-mesh" particles.

The range of application of the apparatus is almost without limitation where sufficient flame space in the combustion chamber can be provided. Scarcely a boiler in existence is so located that it would be impossible to run an 8-in. or a 10-in. delivery pipe from a conveniently located pulverizer to the furnace, thus realizing all of the advantages of mechanical stokers and few of their disadvantages.

The smoke question can be immediately dismissed, as the chemical analysis of waste gases and the practical applications show that there is no smoke when fires are well under way and the air supply is subject to the adjustment which the most ordinary boiler attendance presupposes. As there is no particular effort or concentration demanded in the occasional adjustment of dampers, the production of smoke is absolutely inexcusable. The waste gases have a gray or brown tint due to the suspension of the finest dust particles representing about 70 per cent. of the foreign matter in the coal. The remaining 30 per cent. is gradually accumulated in the setting and in chambers exterior to the boiler. No accumulation in the flues is noticed since powdered material is devoid of all adhesive properties, the velocity of the gases in the flues being sufficient to keep them clean.

This manner of disposal of the ash will in some locations be very objectionable, leading, as it probably does, to the necessity of washing the gases by a water spray before they leave the stack. It is conceivable that the pulverizer can be equipped with a fan chamber to deliver all the air required for combustion at such a pressure as to overcome the resistances ordinarily imposed on the natural draft. With this arrangement, dust fuel will become acceptable in the most populous communities.

Another unexpected difficulty developed in the use of commercial screenings from the appearance of bolts, nuts, washers and railway spikes with the coal. If noticed in time these pieces can be readily dislodged from the pulverizer through a by-pass valve provided for such emergencies; but their continued presence is sure to destroy the beaters mounted radially on the shaft. Such destructive agents can be removed by passing all the fuel over powerful electro-magnets.

TABLE I.—SUMMARY OF RESULTS OF BOILER TRIALS.

72 in. x 20 ft. Horizontal Tubular Boiler.

Kellyville Screenings.		Dust fuel.	Hand firing.
Duration of trial	Hrs.	8.	8.
Average gage pressure	Lbs.	92.6	87.7
Average feed temperature	Deg. F.	37.9	41.9
Average flue gas temperature	"	444.	545.0
Average boiler room temperature	"	35.	49.0
Average stack draft (in. of water)		....	0.62
Average quality of steam		0.9697	0.9652
Average factor of evaporation		1.219	1.215
Average horse-power of boiler		149.	157.
Total water delivered	Lbs.	34,777.	37,328.
Total water actually evaporated	"	33,723.	36,029.
Total water from and at 212 deg. F	"	41,115.	43,785.
Total coal fired	"	5,928.	7,680.
Total dry coal fired	"	5,092.	6,600.
Total combustible fired	"	3,913.	5,580.
Actual evaporation per hour	"	4,215.	4,504.
Equivalent evaporation from and at 212 deg. F. per hour	"	5,140.	5,473.
Coal fired per hour	"	741.	960.
Dry coal fired per hour	"	637.	825.
Combustible fired per hour		489.	698.
Actual evaporation per lb. of coal	"	5.69	4.69
Equivalent evaporation from and at 212 deg. F. per lb. of coal	"	6.94	5.70
Equivalent evaporation from and at 212 deg. F. per lb. of dry coal	"	8.07	6.63
Equivalent evaporation from and at 212 deg. F. per lb. of combustible	"	10.51	7.85
Actual evaporation per sq. ft. of heating surface per hour	"	3.12	2.34
Equivalent evaporation from and at 212 deg. F. per sq. ft. of heating surface per hour	"	3.81	4.05
Coal fired per sq. ft. of heating surface per hour	"	0.549	0.71
Combustible per sq. ft. of heating surface per hour	"	0.363	0.51
Coal per sq. ft. of grate area per hour	"	*(22.45)	29.09
Dry coal per sq. ft. of grate area per hour	"	*(19.29)	25.00
Moisture in coal	Per cent.	14.10	14.06
Ash in dry coal	"	23.17	15.46
C O in waste gases	"	10.40	6.40
C O in waste gases	"	0.00	0.00
O in waste gases	"	8.56	10.87
N in waste gases	"	81.04	82.73
Air required by fuel per min	Cu. ft.	1,136.	1,567.
Air entering furnace per min	"	1,885.	3,096.
Dilution coefficient		1.66	1.98
Complete Analysis of Dry Coal.			
Ash	Per cent.	21.28	14.72
Hydrogen	"	4.39	4.65
Nitrogen	"	0.96	1.00
Oxygen	"	9.82	12.02
Sulphur	"	2.22	1.49
Carbon	"	61.33	66.09
Theoretical heat value per lb	B. T. U.	10,850.	12,090.

*This is an equivalent since the powdered fuel was not burned on a grate.

TABLE II.—HEAT BALANCE FOR DUST FUEL TEST.

72 in. x 20 ft. Horizontal Tubular Boiler, 1,350 sq. ft. of Heating Surface.

British Thermal Units per Minute.

Cr.	Per cent.	B. T. U.	Dr.	Per cent.	B. T. U.
Heat absorbed by boiler:			10.616 lbs. of dry coal with heat value of 10,850 B. T. U. per lb.		
85.66 lbs. of water evaporated from and at 212 deg. F.	71.84	82,747			
Loss due to moisture in coal:					
1.773 lbs. water evaporated and superheated to 444 deg. F.	1.62	1,867		100.00	115,180
Loss due to heat carried away by chimney gases:					
6.51 lbs. carbon;					
0.465 lbs. hydrogen;					
151.47 lbs. air.					
158.345 lbs. total raised from 58 deg. F. to 444 deg. F.	12.74	14,670			
Other losses. Radiation moisture in air and unaccounted for by difference	13.80	15,896			
	100.00	115,180		100.00	115,180

Heat Balance for Hand Firing Test.

Cr.	Per cent.	B. T. U.	Dr.	Per cent.	B. T. U.
Heat absorbed by boiler. 91.22 lbs. of water evaporated from and at 212 deg. F.	52.20	86,800	13.75 lbs. of dry coal burned per minute with a heat value of 12,090 B. T. U. per lb.		
Loss due to moisture in coal. 2.25 lbs. of water evaporated and superheated to 545 deg. F.	1.40	2,340			
Loss due to heat carried away by chimney gases:					
9.08 lbs. of carbon;					
0.61 lbs. of hydrogen;					
220.10 lbs. of air.					
259.79 lbs. total raised from 49 deg. F. to 545 deg. F.	18.60	30,930		100.00	166,237
Loss due to radiation, moisture in air, carbon in the ash pit and unaccounted for by difference	27.80	46,167			
	100.00	166,237		100.00	166,237

Table III.—Comparison of Results Attained on a 72 in. x 20 ft. Horizontal Tubular Boiler.

Boiler delivering 5,175 lbs. of steam per hour. 150 B. H. P.

Coal (Kellyville screenings).	Dust fuel. (Lbs.)	Hand firing. (Lbs.)
Evaporation per lb. of dry coal from and at 212 deg. F.	8.07	6.63
Lbs. of dry coal required to evaporate 5,175 lbs. of water from and at 212 deg. F.	639.0	778.0
Equivalent commercial coal with 14 per cent. moisture	743.0	905.0
Coal equivalent of 12 h. p. to operate pulverizer at 5 lbs. per hour	60.	0.0
Total coal chargeable to 5,175 lbs. of steam or 150 b. h. p.	803.	905.
Saving in favor of dust fuel	102.	......
Per cent. of saving in favor of dust fuel	10.75	......

Santa Fe Shop Improvements at Albuquerque.

The improvements recently completed at the Albuquerque shops of the Atchison, Topeka & Santa Fe included the building of a new machine and erecting shop and the equipping of the entire plant with electric light and power. The machine and erecting shop is divided longitudinally by a track running through the center, on one side of which are 15 erecting pits and on the other the machine tools. The line shaft for driving these tools is divided into four sections, each of which is driven by an electric motor. The boiler shop has six pits, and all of the tools of the shop are electrically driven, with individual motors on the riveter hoist and punch and shears. The transfer-table between the machine and boiler shops has been equipped with an electric motor, also the turntable.

There are two power units composed of Ideal tandem-compound engines, direct-connected to generators, the engines being rated at 275 h.p. In addition to furnishing light and power to the shops this plant supplies something over 800 arc and incandescent lamps in the Alvarado, the fine new hotel recently completed by the Santa Fe.

One pit in the erecting shop is occupied by an electric hoist capable of raising engines bodily off their wheels and trucks and lowering them upon specially designed trucks. They are then run out onto the transfer table and shifted to the proper stall. The engine remains on the special truck during repairs and is moved back to the hoist when ready for its driving wheels. The time required to raise an engine, remove the drivers and lower it on to the special truck is about 10 minutes. The hoist was designed by Mr. G. R. Henderson, Superintendent of Motive Power.

Train-Resistance.

BY J. A. F. ASPINALL.

[WITH AN INSET.]

[At a meeting of the Institution of Civil Engineers (British), held last November, Mr. J. A. F. Aspinall, the accomplished General Manager of the Lancashire & Yorkshire Railway, presented a paper setting forth the details and results of some very elaborate experiments to ascertain the resistance of trains. Some months ago we printed a short synopsis of that paper, giving particularly the formula deduced. We have not felt at liberty, however, until now, to print the paper at any length, because it was the property of the Institution until published in their Proceedings. That obligation no longer exists, and below will be found copious extracts from the paper. Later we shall hope to give something from the discussion.

The experiments were numerous, elaborate, and carefully conducted, and the results are a considerable step forward in this most complicated and difficult inquiry. The elaborate study of atmospheric resistance we have felt obliged to omit. Furthermore, we have not cared to give space to the very interesting collection of formulas which Mr. Aspinall has gathered. In the pamphlet Proceedings will be found 55 train resistance formulas, beginning with D. R. Clark in 1855, and coming down through all the modern investigators. We reprint a few of the 55 formulas, together with the curves plotted from them.]

As there are no published records of modern experiments on the resistance of trains on English railroads, the author considers that it may be of interest to give an account of a number of experiments made on the Lancashire & Yorkshire Railway with modern rolling stock, in which care was taken to record as far as possible all the conditions under which the experiments took place, with illustrations of those parts of the rolling stock which really affect the question of haulage.

Air Resistance.—A lengthy series of experiments was tried in 1898-99, and they were very carefully recorded; but the general result was such as to induce the author to repeat them, making such improvements in the recording-apparatus as were found to be necessary, and arranging for much more elaborate records of the wind-pressure to be taken, as the wind was found to be such an important factor in the final result.

The experiments recorded in this Paper were carried out between June, 1899, and January, 1900, an attempt being made to determine accurately both the velocity and the direction of the wind in each experiment.

In order to obtain a continuous record of the resultant velocity of the wind, due to its natural velocity and the velocity of the train, an anemometer, having six Robinson cups, 5 in. in diameter, set equidistant from one another and with the centers 1 ft. 6 in. from the vertical axis, was fixed 15 in. above the middle of the roof of the car. This vertical axis, which was supported by a pivot with anti-friction rollers, was connected by bevel-gearing with a Boyer speed-recorder marking on the same roll of paper as the other apparatus. The recorder was also connected with a speed-gage so that the velocity at any moment could be read off if required. This apparatus was calibrated by making numerous comparisons with the ordinary fan or Hall anemometer at different speeds.

Measurements were also taken at various heights and distances from the top and the sides of the car with three Hall anemometers. The accuracy of these instruments was vouched for by the maker (Casartelli, of Manchester). The pressure on various parts of the car due to the velocity of the wind was ascertained by 27 tubes, including a Dines anemometer and a Pitot tube fixed at various points, coupled to U-water gages on a board suspended in the car.

In addition to these fixed tubes a number of wind-collectors, composed of hemispherical cups fixed on the ends of tubes, similar to those used by Professor Nipher, were employed to ascertain the pressure at different angles and distances. These also were connected to U-tubes similar to those referred to above. The direction of the wind was observed by means of a swallow-tail vane fixed 1 ft. 7 in. above the center of the car and supported by a pivot and anti-friction rollers.

In the previous experiments the velocity and direction of the natural wind was taken at each end of the run, where in every case it was affected, more or less, by the surrounding buildings, etc. During the experiments here described, however, it was thought desirable to have the natural wind taken at a predetermined position in open country near the middle of the run; the velocity was obtained by a Hall anemometer held 8 ft. above rail-level, this being about the center of the body of the train, and the direction of the wind was observed by means of a delicately balanced vane. By the aid of these readings it was possible to calculate the theoretical resultant direction and velocity of the wind at any speed, and thus to verify the results obtained with the other wind-recording apparatus.

Apparatus.—The apparatus fixed in the car allowed two separate diagrams to be taken on two charts, one a "distance-speed" and the other a "time-speed" chart. The former chart was worked from a Boyer speed-recorder, and had marked on it: 1. Tractive effort; 2. Thrusting effort; 3. Speed of train, in miles per hour; 4. Velocity of the wind; 5. Vacuum in train-pipe and application of the brake; 6. Time in minutes; 7. Distance traveled; 8. Place where indicator-diagrams were taken.

The latter chart was moved at a uniform speed by the clock-work of a chronotachometer and recorded: 1. Tractive effort; 2. Thrusting effort; 3. Speed of train, in miles per hour; 4. Revolutions of the car-wheels; 5. Time occupied on journey.

Electrical bell-pushes were provided for signalling purposes, and also for marking the diagrams at any desired point.

The wheels of the recording-car were turned perfectly parallel, and of exactly the same diameter, so as to prevent any error arising from the coning of the tires; the motion was transmitted from the axle to the speed-recorder by a leather belt and a steel band, provided with the necessary adjusting-apparatus.

The Boyer speed-recorder was tested for speeds between 5 miles and 77 miles per hour. The results of the test were:

Duration of Test. Minutes.	Actual Speed. Miles per hour.	Recorded Speed. Miles per hour.
5	5.1	5.0
3	20.03	20.5
3	38.6	39.0
2	50.02	50.0
2	58.7	59.0
5	71.9	72.0
4	77.0	77.5

Vehicles Experimented With.—It was thought advisable to make all the experiments with a train of bogie-coaches fitted with oil axle-boxes, this being the most modern type of coach. The majority of the experiments were carried out with a special train composed of five oil-lubricated bogie-coaches and the grease-lubricated dynamometer-car, being altogether 284 ft. 10 in. long over bodies; this was taken as representative of average express trains on the Lancashire & Yorkshire Railway. All the trains were run empty and were overhauled before being experimented with, special care being taken each day to see that the bearings were properly lubricated and the brake-blocks clear when running.

Coasting experiments were made to ascertain if the results obtained by this method agreed with those obtained with the dynamometer-car, and particularly to ascertain the resistance at low speeds. A few experiments were also made to obtain the starting-resistance, by seeing on what incline the train would start by itself. On several high-speed runs indicator-cards were taken, allowing of a comparison being made between the work done in the cylinders and that available at the draw-bar of the tender.

Method of Experimenting.

The method of conducting the experiments was as follows:

The position of the regulator and reversing-gear on the engine was marked for each trial, these positions being governed by the speed at which it was desired to run. After the regulator and wheel had been set they were left in position during the whole of the run, the engine being allowed to run at whatever speed it could, and steam-pressure being kept as constant as possible. Both the outward and return journeys were made with the engine set in exactly the same position. This was judged to be the best method of ascertaining the tractive force required to haul the train at different speeds, as the acceleration which would have been caused by altering the position of the regulator was entirely eliminated; and the gradients being very slight, it was possible to obtain readings at a constant speed for a mile or more.

As the trials were mostly carried out on week-days, the speeds at which runs were made were governed to a large extent by the time allowed between the runnings of the ordinary trains. Special speed-trials, at either high or low speeds, had to be made on Sundays.

The actual diagrams, however, do not consist of regular curves as shown, because the pencil is continually oscillating; the lines shown in the diagrams are therefore only mean curves of such oscillations. They are particularly large at starting, as will be seen from the two charts in Figs. 5, which were taken whilst starting from Horwich Station with a local train. The rate of travel of the paper has been increased so as to magnify the oscillations horizontally. It will be noticed that they decrease somewhat unevenly as the speed increases.

Fig. 6, Plate 2, shows graphically all the results of the experiments made with the dynamometer-car with trains of 5, 10, 15, 20, 25 and 29 coaches. Ordinates numbered to correspond with the several experiments, which are arranged in order of speed, show for each experiment the speed, tractive effort, direction and velocity of the wind. The speed is shown by a full line, the wind-velocity by a dotted line, and the tractive effort by a chain-dotted line.

It will be seen from the diagram that in nearly all individual cases the variation of tractive effort does not correspond with the variation in speed or in wind-velocity. For example, No. 36 shows a tractive effort of 4.63 lbs. per ton with a speed of 25 miles per hour, the wind velocity being 43 miles per hour and its direction making an angle of 4 deg. with the direction of motion of the train; whilst in No. 37, with a precisely similar speed, the tractive effort increases to 4.86 lbs. per ton, or by 5 per cent., although the velocity of the wind has fallen to 12.3 miles per hour, which is only 28.6 per cent. of the preceding case, the angular direction being 11½ deg. Example No. 40 was taken at the same speed, with the same velocity and direction of wind, but the tractive effort has risen to 6.67 lbs. per ton, or an increase of 37.2 per cent. above that of No. 37. As the speed increases, however, it will be noticed that the variation of the tractive effort for a given speed agrees more closely with the variation of wind velocity. This will be particularly noticed in Nos. 156, 157, 160 and 161, 167, 168 and 169, 198, 199 and 200.

In several instances the resistance is greater on a falling gradient, or on a level, than on a rising gradient, at the same speed and with the same velocity of wind, although in most cases it is the reverse. Variations of this kind cannot always be accounted for, as there are so many disturbing forces in train-resistance. In fact, it makes a difference to the oscillations of the recording pencil in which direction the natural wind is blowing, even if only a slight breeze. It is obvious that on passing from an embankment to a cutting on a windy day there will be great variation in the wind-pressure, and consequently in the pull on the dynamometer. If such facts could be quickly ascertained it would only be necessary to make a few runs to determine "train-resistance"; but it was found that only the mean of a great many observations can give any idea as to how the resistance varies.

Although there is little agreement in individual cases, it will be seen that, taking the results as a whole, the speed of the train and the velocity of the wind increase in the same ratio, whilst the tractive effort increases in a different ratio from the wind and the speed. As might be anticipated from theoretical considerations, the angle between the direction of resultant velocity of the wind and the direction of motion of the train decreases as the speed increases.

The results of these tests on trains of different lengths are plotted in Figs. 7-10, Plate 2. By far the greater number of tests have been made with the 5-coach train.

In Fig. 7 a mean curve has been drawn through the points representing the resistance (of five bogie-coaches and dynamometer-car) at various speeds from 3.5 miles to 79 miles per hour. This curve agrees with the formula—

$$R = 2.5 + \frac{V^{\frac{5}{3}}}{58.7} \quad \ldots\ldots (1)$$

where R = resistance in lbs., per ton drawn.
V = velocity of train in miles per hour.

The composition of this formula will be dealt with later.

Other tests were made with the dynamometer-car and 10, 15, 20, 25 and 29 bogie coaches. Curves have been drawn through the results to represent a mean of the readings, as will be seen from Figs. 7-10. These curves were found to correspond with formula (1), with a denominator varying directly with the length of the train. The formula thus modified is—

$$R = 2.5 + \frac{V^{\frac{5}{3}}}{50.8 + 0.0278\,L} \quad \ldots\ldots (2)$$

where L = length of train in feet over the coach-bodies.

This becomes—

For 10 coaches $$R = 2.5 + \frac{V^{\frac{5}{3}}}{65.82} \quad \ldots\ldots (3)$$

For 15 coaches $$R = 2.5 + \frac{V^{\frac{5}{3}}}{73} \quad \ldots\ldots (4)$$

For 20 coaches $$R = 2.5 + \frac{V^{\frac{5}{3}}}{80} \quad \ldots\ldots (5)$$

So few diagrams were taken with trains of 25 and 29 coaches that no definite formula has been worked out for them: but in Fig. 11 curves have been plotted for 5 to 20 bogie-carriages according to the above formula.

Coasting Experiments.

In order to verify, if possible, the results taken with the dynamometer-car, a number of kinetic-energy or "coasting" experiments were made. These experiments were carried out with the same train and over the same line as the dynamometer tests, and were made as follows:

Two points were marked, one at each end of the line. The engine, being placed behind, started the train in motion about a mile in advance of one of the points, the speed of the train being accelerated through this distance. When the point was reached, steam was shut off and the brake was applied to the engine, which, not being coupled, was separated from the train. At the instant of separation the apparatus in the car was started, being so arranged that each revolution of the car-wheels was marked on a revolving drum, which was rotated by clock-work. These revolutions of the car-wheels were also observed independently every half-minute, by two observers, with a Harding counter. The mile-posts were also noted by another observer. From these particulars it was possible to ascertain the speed at any instant. The resistance was calculated from the change of kinetic energy.

The results obtained with trains of various lengths, consisting of from one to 11 coaches, and without engine, are shown in Figs. 12-18, Plate 3. It will be observed that the results vary, and the author concludes that this is due to excessive lateral movement, owing to wind and crowding. This latter takes place owing to the extra wind-resistance on the first coach, which allows the following coaches to come forward slightly, and therefore they have a tendency to oscillate and develop a certain amount of flange-friction. This does not occur when the train is being pulled, as all the couplings are then kept tight, and the locomotive encounters the greater part of the head-wind resistance. Although irregular, the resistances found with the dynamometer-car and five and ten coaches agree closely with the formulas (1) and (3), as will be seen from the curves for five and for ten coaches (Figs. 17 and 18, Plate 3).

In addition to this it is interesting to note the gradual decrease of resistance per ton as the length of the train increases. The resistance at very low speeds (i.e., when stopping) is in all cases exceedingly high. It will also be seen that the resistance of the grease-lubricated four-wheeled dynamometer-car increases rapidly with the speed, Fig. 12, Plate 3.

Experiments were also made to determine, if possible, the tractive resistance of an engine and train, the locomotive being a radial tank-engine. In these experiments the engine was coupled to the train, and on reaching the starting-point steam was shut off and the cylinder-cocks were opened. The engine and train were allowed to come to rest in each experiment, observations being made similar to those mentioned above. The results are shown in Figs. 19-25, Plate 3, and are not as absolutely comparable as they might be, owing to the fact that the velocity of the wind was greater than when tests were made with a train only. They show, however, that the resistance per ton of the locomotive is considerably higher than that of the carriages, and also that the engine-resistance increases at a higher rate. In both cases it is noticeable that the effect of the wind, as judged by the difference between the resistance when running with and when running against it, is less at high than at low speeds. The effect of running with and against the wind is clearly shown in Figs. 12 and 20.

It is evident that a large number of coasting-experiments would have to be made in order to obtain any reliable data, and it is doubtful whether, even then, the resistance of drawn coaches could be deduced from them.

Atmospheric Resistance.

Very few investigators have dealt in detail with the question of wind-resistance, although from the experiments here described it appears to be of great importance. Owing to this it was thought advisable to obtain as many particulars about it as possible, though it was found to be a very difficult matter to ascertain anything definite as to its effect. [The details of these very elaborate experiments are not reprinted by us.—EDITOR.]

The highest pressures are found, as would be expected, on the windward top portion of the front and the center of the roof. It should be noted, however, that there is considerable pressure on the leeward side, amounting to about 60 per cent. of that on the windward side. At the back it will be seen that there is a slight pressure at the top and the bottom of the leeward side, whilst the only large vacuum is at the middle of the top.

With the recording Robinson anemometer it was noticed that a great and almost instantaneous decrease in the velocity of the wind, in some cases as much as 30 miles per hour, occurred whilst passing under bridges. This is evidently due to a banking up of the air above the train, and against the bridge. It was particularly noticeable at Croston Station Bridge, and it is interesting to mention that this is a point at which many tail-lamps have been known to be blown out.

The maximum observed velocity of the wind was 76 miles per hour—considerably lower than the theoretical velocity, which was 94.7 miles per hour (Fig. 6, Plate 2).

The results obtained with the collectors and anemometers are shown in Fig. 32. It will be observed that these results agree very closely with the curve $P = 0.003 V^2$. This appears to be rather high, being the same as that arrived at by Mr. Dines and higher than that found by Professor Nipher, viz., $P = 0.0025 V^2$, as no account is taken of atomizing action as by Mr. Dines. By "atomizing action" is meant the vacuum caused by the air disturbed by a body moving through it. It is probable, however, that the formula found is nearly correct for coaches, as it would seem that the cups would have a tendency to augment the pressure, and this would counteract the rarefaction at the back in the case of the train.

Starting-Resistance.

To determine the starting-resistance, experiments were made on several occasions to ascertain if the train consisting of dynamometer-car and five bogie-coaches would start on various inclines. On a gradient of 1 in 132, equivalent to a tractive effort of 16.9 lbs. per ton, with a very slight wind blowing against the train at an angle of 30 deg., there was no movement. When the wind was blowing with a velocity of 6.15 miles per hour at right-angles to the train it just moved. On another occasion the same train, on the same incline, with the wind blowing 9.65 miles per hour with the train at an angle of 60 deg., started more readily. From this it is concluded that the starting-resistance is about 17 lbs. per ton, and it has been shown as this in the diagrams.

Axle-Friction.

With regard to axle-friction, tests were made to ascertain the comparative resistance of two similar trains, one fitted with brass and the other with white-metal bearings, having similar lubrication. A number of runs with the dynamometer-car showed a very slight difference, but not sufficient to indicate definite figures.

On Sunday, the 19th November, 1899, the trains were allowed to coast, with an interval of 12 minutes between them, down Whalley Bank. Particulars of the runs are given in Fig. 33, Plate 3. By comparing the maximum speed attained, the train with the white-metal bearings was shown to have a resistance 0.7 lb. per ton less than the one with brass bearings, but comparing the distances run it had a resistance only 0.148 lb. less per ton. These speed-curves were plotted from the figures giving the distance traveled every half-minute.

Analysis of Formula.

Train-resistance is made up of several factors, and an attempt has been made to analyze the formula

$$R = 2.5 + \frac{V^{\frac{5}{3}}}{50.8 + 0.0278\ L}$$

which relates to bogie-coaches with oil-lubricated axle-boxes.

In Fig. 34 this formula has been applied to a train of five bogie-coaches. The axle-friction per ton does not vary with the length of the train but with the weight on the boxes. Mr. Beauchamp Tower's experiments for the Committee on Friction appointed by the Institution of Mechanical Engineers, show that above a certain velocity the coefficient of friction increases slightly with some power of the speed. From the conditions agreeing most closely with the rolling stock experimented upon, the following table has been compiled:

Speed of Axle. Feet per minute.	Speed of Train. Miles per hour.	Coefficient of Friction.	Axle-Friction. Lbs. per ton.
157	20.0	0.01	1.65
209	26.6	0.0087	1.43
262	33.4	0.0085	1.4
314	40.0	0.0078	1.29
366	46.6	0.0085	1.4
419	53.3	0.01	1.65

The axle-friction has been calculated from the formula:

$$R_a = \frac{\mu\ d_a\ L_a}{d_w\ W} \times 2240$$

where

R_a = axle-friction, in lbs. per ton drawn.
μ = coefficient of friction.
d_a = diameter of axle, in inches.
d_w = diameter of wheel, in inches.
L_a = load on axle in tons.
W = total weight of train drawn, in tons.

Pad-lubrication has been taken, as it seems to correspond most nearly with the lubrication of the axle-boxes used on this line. The curve has been drawn for speeds between 20 miles and 53.4 miles per hour, the range which Mr. Tower's experiments cover, and for the sake of comparison it has been extended to 80 miles per hour, the assumed portion of the curve being shown by a dotted line.

As already mentioned, the views of various experimenters on the relation between the velocity of the train and the pressure of air are very divergent. The elaborate experiments of Professor Goss, carried out with small models of carriages, gave the following results:

First coach.............. $R_w = 0.001\ V^2$
Second coach..............$R_w = 0.00003\ V^2$
Last coach .... $R_w = 0.00026\ V^2$
Any intermediate coach ...$R_w = 0.0001\ V^2$

R_w being pressure of the wind in lbs. per square foot.

This, applied to the train consisting of five bogie-coaches and the dynamometer-car, gives the pressure per square foot of cross section as $0.00164\ V^2$. As previously stated, it was found that the relation between velocity and pressure, as experimentally ascertained by means of collectors and anemometers, could be expressed by

$$R_w = 0.003\ V^2.$$

Both these curves have been plotted in Fig. 34 in terms of resistance per ton drawn, taking the effective cross section as 70 sq. ft. and the weight of the train as 115.4 tons. It will be seen that although Prof. Goss includes skin-friction, his result is less than that obtained from the author's experiments.

The lower diagram, Fig. 34, shows the total tractive resistance separated into its components:

R_a = axle-friction.
R_w = atmospheric resistance.
R_m = miscellaneous resistances, which include oscillation, concussion, flange-friction, rolling-friction, etc.

These miscellaneous resistances have been plotted in the upper diagram, Fig. 34, and their value approximates to $R_m = \frac{V}{5.4} - 1$.

For comparison both Smeaton's and Prof. Nipher's atmospheric resistance has been plotted in Fig. 34, along with that found by Prof. Goss and by the author. It will be noticed that Smeaton's atmospheric resistance is 50 per cent. of the total resistance at 80 miles per hour, whereas the author's atmospheric resistance amounts to 42 per cent. and the miscellaneous resistances to 50 per cent. of the total resistance at 80 miles per hour.

A similar diagram has been worked out for a train consisting of 20 bogie-coaches and the dynamometer-car, Fig. 36. In this case Prof. Goss's formula is slightly above the value $R_w = 0.003\ V^2$ previously taken, being in fact $R_w = 0.00314\ V^2$. The two corresponding curves are so close together that they would be undistinguishable on the diagram, and they have therefore been shown as one line.

The author's miscellaneous resistances are plotted in the upper diagram and their value approximates to $R_m = \frac{V}{4.84} - 2$.

It will be noticed that these miscellaneous resistances for a 20-coach train increase slightly more than those for a five-coach train, as the speed increases. This may be due to the fact that oscillation and probably flange-friction are greater at high speeds with a long train than with a short one.

Indicator-Diagrams.

On several runs indicator-diagrams were taken from the engine drawing the dynamometer-car and train, the tractive effort and the speed being marked the moment the card was taken. From the speed of the train and the pull on the car draw-bar, the horse-power has been calculated and compared with the horse-power developed in the cylinders. The figures show that there is no well-defined relation between the two. They seem to be about the same as those taken by Mr. W. M. Smith with Northeastern Railway engines. The actual relation in these cases is not likely to be obtained with any degree of accuracy without the use of a continuous indicator on the cylinders and much larger recording-apparatus in the car, with apparatus for ascertaining the acceleration, which is the most important factor.

Effect of Curves.

It was found that the extra resistance due to the curvature of the line could not be accurately ascertained by means of the recording-apparatus. This is due to the fact that the engine on entering the curve is the first to encounter the extra resistance, which causes it to lose speed slightly relatively to the train; consequently the tension on the draw-bar is somewhat decreased. The objection is overcome when the whole train is on the curve and has settled down to a normal speed; by that time, however, the engine was leaving the curve on which the experiments were made.

Conclusion.

The formulas given for train-resistance are necessarily approximate formulas only, giving average results.

The experiments described were carried out under the most favorable conditions in regard to weather. Thus the formulas are only deduced for what may be termed the summer resistance; the winter resistance would probably give rather different results. The separation of the value of the total resistance into its components is necessarily somewhat of an approximation, and to ascertain the mean values of those components would require many experiments with apparatus of a different type from that used.

The author desires to point out that these experiments can only be taken as recording the results obtained with the particular coaches used, as it is quite possible that variations in the wheel-base of the bogies, or in the dimensions of the journals, would have most important results. The great difficulty of conducting trials of this kind on a crowded line is well-known to those experienced in railway work, and the limited opportunities for experiment cause so many delays and consequent prolongation of the time occupied, that many points have remained unconsidered, which the author hopes may be taken up by others. The publication of all the main de-

Formulas for Train-Resistance.

R = tractive resistance in lbs. per ton (2,240 lbs.).
V = velocity in miles per hour.
W = weight of engine and tender in tons (2,240 lbs.).
w = weight of carriages in tons (2,240 lbs.).
A = area of front of train in square feet.
L = length of train in feet.

No.	Authority.	Value of R.	Conditions.
1	Clark	$8 + \frac{V^2}{171}$	Whole train
2	"	$6 + \frac{V^2}{240}$	Carriages only
3	"	$12 + \frac{V^2}{114}$	Whole train Narrow gage
4	"	$6 + \frac{V^2}{240} + \left\{\left(\frac{2 + V^2}{600}\right) \times \left(\frac{W + w}{W}\right)\right\}$	Engine and tender
5	Harding	$6 + \frac{V}{3} + \frac{(V^2 \times 0.0025 \times A)}{w}$	Carriages only
7	"De Monte Alto"	$6 + \frac{3\ (V - 10)}{10}$	Carriages only
8	Henderson	$3.36 + \frac{V^2}{193.5}$	
13	Wellington	$4.48 + \frac{V^2}{162}$	Engine and train
15	Searles	$\left\{5.4 + 0.006\ V^2 + \frac{0.0006\ V^2\ W^2}{W + w}\right\}$	Whole train
16	Chanute	$\left\{5.6 + 0.008\ V^2 + \frac{0.3\ V^2}{w}\right\}$	Passenger cars
17	Ricour	$4.48 + 0.0902\ V$	
21	Barnes	$4.48 + 0.179\ V$	
22	Baldwin Co.	$3.36 + \frac{0.56\ V}{3}$	
23	"	$1.68 + 0.224\ V$	47 to 77 miles per hour
26	Sinclair	$2 + 0.24\ V$	
27	Dodd	$12.5 + 0.224\ V$	Whole train
35	Deeley	$3 + \frac{V^2}{290}$	
36	Wolff	$3 + \frac{V^2}{250}$	
48	Barbier	$\left\{3.58 + 1.658\ V \times \left(\frac{1.609\ V + 50}{1,000}\right)\right\}$	Four-wheeled coaches
49	"	$\left\{3.58 + 1.644\ V \times \left(\frac{1.609\ V + 10}{1,000}\right)\right\}$	Bogie coaches
50	"	$\left\{8.51 + 3.24\ V \times \left(\frac{1.609\ V + 30}{1,000}\right)\right\}$	Locomotive and tender
55	Aspinall	$\left\{2.5 + \frac{V^{\frac{5}{3}}}{50.8 + 0.0278\ L}\right\}$	General formula bogie-coaches oil axleboxes

tails of these experiments should enable the results indicated by the author to be criticized and checked in such a way as to eliminate any inaccurate statements.

The author has to express his acknowledgments to Mr. H. Fowler, Assoc. M. Inst. C.E., and to Mr. A. C. Rogerson for their assistance in the conduct of the experiments, and in the preparation of the Paper.

In conclusion he wishes to draw attention to the careful experiments on train-resistance made by the officials of French railroads, which have been published from time to time. The formulas given by various authorities for tractive resistance are tabulated in an appendix, with references to the sources of information. Curves corresponding to some of these formulas, for speeds up to 100 miles per hour, are shown in Fig. 39.

Master Car Builders' Reports.

(Continued from page 458.)

SIDE BEARINGS AND CENTER PLATES.

Your Committee on Side Bearings and Center Plates was continued from last year, with instructions to report on

1. A design of center plate, with a view to adopting dimensions for standards or recommended practice.
2. The location of side bearings.
3. Uniform relation between center plate and side bearing.
4. The merits of anti-friction side bearings for relieving the center plate from part of the load.
5. Will the use of anti-friction side bearings diminish the resistance between the wheels and rails.

Center Plates.

Your committee has endeavored to obtain data which would enable it to present for your consideration a form of center plate for adoption as standard. Under the direction of Mr. Demarest a series of tests has been conducted of different forms of center plates and side bearings, and the results, as far as they have been completed, are given herein. . . .

The object of the test with center plates was two-fold; first, to ascertain the best metal for center plates; second, to define, if possible, the best shape. In making the test, two male center plates were bolted on the opposite sides of one end of a lever, each male center plate in turn engaging in a female center plate; the entire construction being forced together by a hydraulic press, from which were obtained total pressures ranging from 15.3 tons to 40.8 tons. The end of the lever in turn was moved through an arc by means of an air cylinder; an indicator and reducing motion being attached, in order to ascertain the amount of work done in turning the male plates in the female plates under the different pressures obtained.

The result of these tests is shown in detail, graphically and in statement form, on data sheets. The tests for side bearing friction were made in practically a similar manner, with the exception that the lever was pivoted at a point which would correspond to the average distance of side bearings from king bolt.

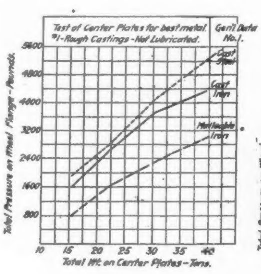
In order to ascertain, if possible, the best material for center plates, a number of plates were made as per plate "A," of three different materials: cast iron, malleable iron and cast steel. We were unable to obtain pressed steel plates of equivalent area or shape. The area, generally, of the plates was 100 sq. in.

Test No. 1 of this series was made with the castings as they were received from the manufacturers, with no dressing or cleaning whatever. The cast steel, which gave the highest resistance, was extremely rough, had thick scale, fused patches on the surfaces, lumpy fillets, fins around the core holes, etc. The cast-iron was not much better, and as a consequence the friction is close to the steel. The malleable plates were very smooth, clean castings, and gave a very much lower resistance. The results of this test show the difference in friction or resistance due to the varying smoothness of the surface.

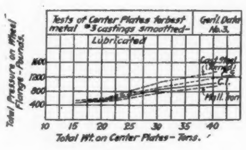
Test No. 2 of this series was made by grinding the surfaces with an emery wheel, and chipping off fins and lumps in the fillets. This attention is assumed to be about as much dressing as it would be practicable to give the plates in actual practice. The scale was not removed, the casting simply being made smooth. In this test the resistance of the cast-iron and malleable-iron plates varies very little, if any, from the resistance obtained in the first test. The resistance of the cast-steel plates, however, has fallen most materially. The large drop in resistance of the steel plate was thought to be due to the crumbling of the thick, porous scale into a powder, which acted as a lubricant. This view was sustained by the fact that in the next test, with this same plate lubricated, there was but little further drop in the friction, the powdered scale in the latter instance preventing good lubrication.

In test No. 3 the same plates were taken as in previous tests and lubricated. The results of the lubrication are shown very conclusively in the very great drop in resistance.

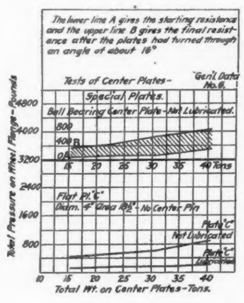
In order to ascertain, if possible, if the low friction of the cast-steel in test No. 2 was due to the powdering of the scale, the cast-steel plates were put in a lathe and the scale turned off and surfaces made smooth. They were again tested and the resistance was found to be lower than before the scale was removed from the surface. The effect of lubrication in test No. 2 practically eliminates the effect of the metal, as the plates of the different materials, when lubricated, have practically the same resistance.



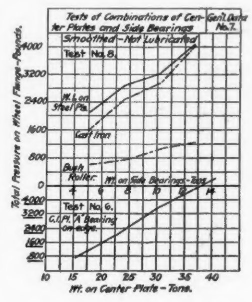
Test No. 1.



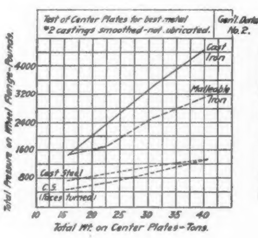
Test No. 3.



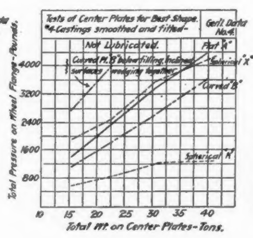
Special Tests.



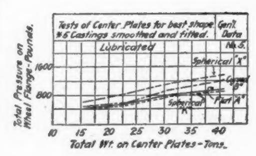
Tests Nos. 6 and 3.



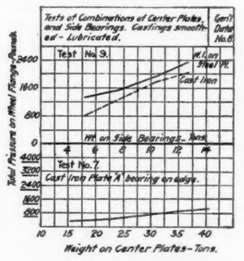
Test No. 2.



Test No. 4.

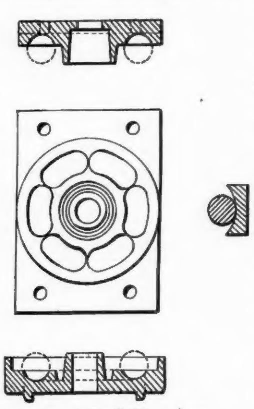


Test No. 5.



Tests Nos. 7 and 9.

The object of the second series of tests was to determine the effect of the shape of the contact surfaces. Having found the effect of rough castings in the first series of tests, all plates were smoothed and fitted. All plates were made of the same metal, cast-iron, and all except that designed by Mr. Klohs, for the Master Car Builders' Committee, had 100 sq. in. area of contact surfaces; the latter plate had 76 sq. in. The results from test of flat plate in series No. 1 were taken for comparison with the curved and spherical plates in series No. 2, and it was expected that the flat plate would have the lowest friction on account of the tendency of the inclined surfaces of the other plates to wedge together. The results obtained from the tests do not at all confirm the theory. They do not show the superiority of the flat plate, and they do show an abnormally low friction for the plate designed by Mr. Klohs. The curves, Nos. 4 and 5, show very plainly, as in the first series of tests, the good effect of lubrication, and indicate that when well lubricated the shape of the plate does not materially affect the resistance. The tests with the lubricant do show, however, that the resistance of the flat plate is lower than the spherical plate "X" and curved plate "B," and about the same as the Klohs plate. We can see nothing in the contour of the Klohs plate which would tend to produce lower resistance than we have obtained from the spherical plate "X." The unsuspected results are due, we believe, to the condition of the surfaces of the plates. The flat plate required but little grinding and fitting to give it a good bearing. The spherical and curved plates, however, fit badly in the rough, and required hard grinding, filing, etc., to bring them to a reasonable fit. The final condition of the surfaces was, therefore, very much better with the spherical and curved plates than with the flat plate. The Klohs plate was ground especially hard on the steeper slopes, and brought down to a good fit in the bottom, which is nearly flat. It is very probable that this plate was ground too hard on the outer ring, concentrating the weight on the inner ring, which is nearly flat and of much smaller diameter, with the resultant low resistance. Further tests in this series will be made by placing the plates in a lathe and fitting them carefully over their entire surfaces, removing all scale and testing them dry and lubricated, in order to settle definitely the conflicting results.

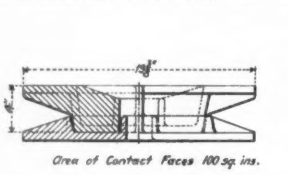


Standard Ball Bearing Center Plate.
Plate P.

Further tests in this series were made with special plates, namely, a small experimental plate "C" with flat surfaces, designed to be used without a center pin, and having a face only 4 in. in diameter, with the idea that it might be possible to use such a plate in conjunction with a roller or other low friction side bearings to assist in maintaining the balance of the car. It was desired to have this plate chilled, as only a very hard surface could stand the heavy pressures. The plates were received soft from the foundry, however. The friction of this plate is very low, but cut badly both when dry and when lubricated; the cutting in both instances taking place in the center of the plate. The second special plate tested in series 3, as shown by test No. 6, was the ball-bearing center plate used by the P. & L. E. R. R.. This plate gave the lowest resistance recorded under the conditions. The balls lie in pockets, which, in length, are about twice the diameter of the ball, and enough larger in width than the diameter to allow the ball to roll freely. The bottom of these pockets curves upwards at the ends, so that the ball begins to roll up hill as soon as it leaves the central position, and as the slope of the pocket is curved, the resistance of the plate to revolution increases as the ball rolls up the slope. The cards taken in this test show a gradually ascending line to a point where the ball seems to lock and stop rolling; the top plate then slides on the balls. The starting and final resistance is shown in tables and on curves for each pressure.

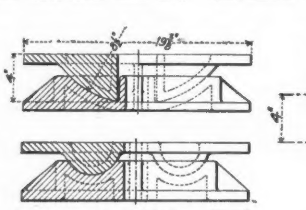
The remaining series of tests were for the purpose of ascertaining, if possible, the combined effect of the center plates and side bearings, as when a car rolls or tips in passing around a curve, and bears on both the center plate and the side bearing. The flat plates "A" were held apart on their lower edges by spreaders, and inclined at an angle equivalent to closing a three-eighths inch clearance, with side bearings 28 in. from the center. The pressure on the back of the plates being uniform, half the weight was taken by the spreaders and half the weight by the edges of the plates. The resistance shown for the plates was therefore doubled to make it comparable with the standard weights used with other tests. The results thus derived are about the same as with the plate bearing on full surface in first series.

The side bearings were tested under comparatively low pressures of from 5 to 12 tons total. It was found impossible to exceed these pressures owing to the fact that the apparatus would lift from the floor. The results of this series show also the effect of good lubrication, and also show that it is from the side bearings that most of the flange resistance is derived. The roller side bearing gives the best results, as was obtained from the roller center plate. All tests, both of center plates and side bearings, show the desirability of thorough lubrication, the castings to be smooth, but scale allowed to remain



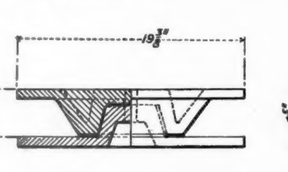
Area of Contact Faces 100 sq. ins.

Plate A.



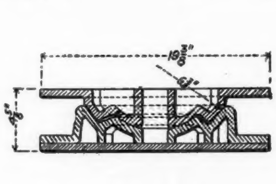
Projected Area Contact Surfaces 100 sq. ins.

Plate B.



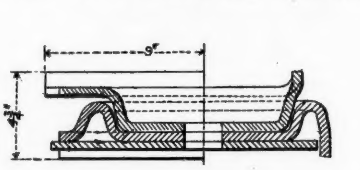
Chilled Contact Surfaces 4" diam.

Plate C.



Designed by Mr. Klohs, Area Contact Surface 76.7 sq. ins.

Plate K.



Pressed Steel Center Plate. Area Contact Surface 46 sq. ins.

Plate S.

on. A thick grease, furnished by the Galena Oil Company for the purpose, was used for lubrication. It is impossible to say how long the grease would last in service. The ball plates and roller side bearings gave very good results, although the ball center plate was badly cut in the upper groove by locking of balls in the pockets. Further, with the larger plates, that is, all plates with the exception of small flat plate "C," no cases of cutting, even under the pressures used, were experienced when there was a good bearing over the entire surface.

It will be noted in the statements that the resistance of the plate to turning is reduced to the wheel flange. We regret that our tests have not been comprehensive enough to permit us to make definite recommendations as to minimum contact area of plates under definite loads, the shape of the plate, or the material from which it should be made. The machine used was rather crude and it is being redesigned with the idea of carrying these tests to a conclusion.

Anti-Friction Side Bearings.

The fourth and fifth subjects assigned to your committee relate to anti-friction side bearings, and are as follows:

The merits of anti-friction side bearings for relieving the center plate from part of the load.

Will the use of anti-friction side bearings diminish the resistance between the wheels and rails?

A circular was addressed to each member asking his co-operation to the extent of furnishing to the committee the result of such tests as had been made, and which was available. Of the members replying those giving opinions or furnishing data control about one-fifth of the car equipment represented in the association.

Twenty-three replies were received, the majority of which were favorable to the use of anti-friction side bearings.

Pittsburgh & Lake Erie R. R. Co.

This company has recently made some tests of ball-bearing center plates and side bearings, which may be of interest to your committee. The results obtained certainly prove the subject to be worthy of the most careful consideration.

On June 1, 1897, one 60,000-lb. capacity gondola car was equipped. The construction consisted of four steel balls 2¼ in. in diameter, between two malleable-iron center plates, the lower plate having four grooves equally spaced, 4 in. long, ¼ of an in. deep at the center, running out to nothing at the end. Lengthwise the grooves conformed to the radius of the bearing surface of the center plate. The upper plate had a groove ¼ in. deep, corresponding to the diameter of the balls and extending all the way around. The side bearings had each one steel ball of same diameter as those used in center plates; each bearing had a groove 15 in. long, same diameter as the ball, straight on the bottom, but curved to proper radius. Balls were protected by deep flanges on each bearing, the top passing down over the outside of the lower. The ends of the flange on upper bearing were cut so as to permit of the greatest curvature of truck.

After the car had been in service three years, proving clearly that the device was entirely practicable, a careful test was made to establish its value in the way of reducing flange and rail wear on sharp curves. A turntable 7 ft. long was made so as to determine, by the use of a dynamometer, the actual power required to displace a truck 2 in. at the end, or 4 in. in its length, equaling a 154 deg. curve. The appended report is the result of the trial:

Curve resistance on cars equipped with the Hartman ball-bearing center plate and side bearing, in comparison with the ordinary flat surface center plate and side bearing.

First Test.

Flat center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing:

		Resistance.
Required to start truck..........	800 lbs.	100%
Required to displace truck 2 in....	1,100 lbs.	100%

Second Test.

Flat center plate, without side bearing.

		Resistance.
Required to start truck..........	275 lbs.	34%
Required to displace truck 2 in....	525 lbs.	48%

Third Test.

Hartman ball-bearing center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing.

		Resistance.
Required to start truck..........	75 lbs.	9%
Required to displace truck 2 in....	450 lbs.	40%

Fourth Test.

Hartman ball-bearing center plate, without side bearing.

		Resistance.
Required to start truck..........	75 lbs.	9%
Required to displace truck 2 in....	325 lbs.	29%

This report, to our mind, clearly indicates two things, namely: We should have a frictionless side bearing to assist cars around curves with high outside elevation, but on straight and level track the load should be carried on the center plate, and by all means on a ball-bearing. The most valuable feature in the center plate in question is the dish in the grooves in the bottom plate, which answers two purposes, one being to keep the balls properly spaced and the other the tendency to straighten the truck quickly after leaving a curve, this being explained by the fact that the sluing of the truck on a curve forces the balls up the inclined plane of the grooves, and as soon as straight track is reached they naturally gravitate back to their proper position.

For your information we append a report of the service of the car in question:

Car built....................	April, 1896
Equipped with Hartman appliance......	June, 1897
Miles run from June, 1897, to date..........	11,323
Approximated loaded mileage..........	7,548
Capacity of car....................	60,000
Tons carried one mile....................	226,440

Wheels show no flange wear up to date.

Wheels show no flange wear up to date.

The perfect condition of the wheel flanges demonstrates its value, not only as increasing the life of the wheel, but reducing train resistance.

L. H. TURNER, *Superintendent M. P.*

Duluth Iron Range R. R. Co.

SERVICE OF AUTOMATIC FRICTIONLESS SIDE BEARINGS.

EFFECT UPON FLANGE WEAR.

Year.	Wheels Removed. All Defects.	Removed for Sharp Flanges.	Per-centage.
1899........	998	254	25.5
1900........	2,248*	463‡	20.6
1901........	1,815†	322	17.7
1902 (January & February).	372	24‡	
	6	6	
	Approximate for year	144 approximate.	06.0‡
	2,232		

* An unusual condition affected this year's record. Over 60 per cent. of the removals, after deducting the wheels taken out for sharp flanges, were removed for flattened wheels in service.

†The automatic frictionless side bearings were in service all this year and affecting flange wear.

‡No removals for sharp flanges on cars with roller bearings.

Not considering the 200 cars built by the Illinois Car & Equipment Company, in 1899, there were 512 ore, flat, box and logging cars equipped with automatic frictionless side bearings in 1899 and 1900. Exact date of applications of the side bearings to 278 ore cars, 38 box cars and 70 flat cars (386 cars in all) in 1899 and 1900 are known, and also the dates of six applications to ore cars in 1901.

The wheel records show that for the year of 1900, after the automatic frictionless side bearings had been just applied, but had not been in service long enough to have appreciable effect upon the wheel flange wear, 463 wheels were removed from box, ore, flat and logging cars for sharp flanges. During 1901, when the bearings were in service on 512 old cars of these classes, and materially affecting the flange wear, only 322 wheels were removed

NOTE: *The columns headed Lever and Flange show pull at the end of Lever and pressure on Wheel Flange.*

Loads.	15.3 tons. Lever.	Flange.	22.5 tons. Lever.	Flange.	30.6 tons. Lever.	Flange.	40.8 tons. Lever.	Flange.
Series No. 1. For Best Metal—								
Test. No. 1.—Tough Castings. No Lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.....	973	1,577	1,637	2,650	2,300	3,725	39.6 tons. 2,548	4,330
Flat Plate "A" Malleable Iron, Area 100 in..	464	788	957	1,627	1,353	2,300	40.1 tons. 1,766	3,000
Flat Plate "A" Cast Steel, Area 100 in......	1,120	1,903	1,676	2,847	2,424	4,125	3,166	5,390
Test No. 2.—Castings Smoothed. No Lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.....	838	1,420	1,375	2,337	1,995	3,390	40.1 tons. 2,605	4,425
Flat Plate "A" Malleable Iron, Area 100 in..	851	1,448	1,012	1,722	1,474	2,503	1,861	3,161
Flat Plate "A" Cast Steel, Area 100 in......	424	720	539	916	675	1,147	798	1,357
Test No. 3.—Castings Smoothed. Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in.....	257	437	336	571	493	838	605	1,029
Flat Plate "A" Malleable Iron, Area 100 in..	273	464	310	526	442	753	559	948
Flat Plate "A" Cast Steel, Area 100 in......	303	515	369	627	528	898	691	1,174
Series No. 1 For Best Metal—								
Test No. 12.—Castings Faced and Fitted in Lathe. No Lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.....								
Flat Plate "A" Malleable Iron, Area 100 in..								
Flat Plate "A" Cast Steel, Area 100 in......	279	474	391	665	576	979	805	1,369
Test No. 13.—Cstgs Faced & Fitted in Lathe. Lubricated.								
Flat Plate "A" Cast Steel, Area 100 in......	257	437	387	657	614	1,043	785	1,335
For Best Shape—								
Test (Extra)—Plates smoothed but not fitted; not bearing in bottom but wedging on the inclined surfaces.								
Curved Plate "B" Cast Iron, Area 100 in.....	1,734	2,947	2352	3,995				
Test No. 4. Cstgs Smoothed and Fitted. No lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.....	838	1,420	1,375	2,337	1,995	3,390	40.1 tons. 2,605	4,425
Spherical Plate "X" Cast Iron, Area 100 in...	1,131	1,923	1,463	2,485	2,110	3,587	2,517	4,275
Klohs Spherical Plate "K" Cast Iron, Area 76 in	347	590	495	842	724	1,230	770	1,309
Curved Plate "B" Cast Iron, Area 100 in.....	660	1,122	1,073	1,824	1,564	2,660	39.6 tons. 2,132	3,621
Test No. 5. Castings Smoothed and Fitted. Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in.....	257	437	336	571	493	838	605	1,029
Spherical Plate "X" Cast Iron, Area 100 in...	358	609	497	845	680	1,155	827	1,407
Klohs Spherical Plate "K" Cast Iron, Area 76 in	255	433	338	575	468	796	570	968
Curved Plate "B" Cast Iron, Area 100 in.....	289	491	340	578	563	956	737	1,254
Series No. 3. Special Plates—								
Test No. 10. Not lubricated. Plate "C" Smoothed.								
Flat Plate "C" Diam 4 in. No Center Pin, Area 12½ in...........	246	418	295	501	356	605	534	906
P. & L. E. Ball Bearing:								
Resistance at beginning of movement....	46	78	68	115	68	115	183	311
Resistance at end of movement.........	200	340	245	416	387	658	617	879
Test No. 11. Lubricated.								
Flat Plate "C" Diam 4 in. No Center Pin, Area 12½ in...........	64	109	81	138	86	146	127	216
Series No. 2. Combined Center Plates and Side Bearings—								
Test No. 6. Plate Bearing on edge. Not Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in......	218	371	570	968	1,047	1,780	1,531	2,601
Friction Doubled..................		742		1,936		3,560		5,202
Test No. 7. Plate Bearing on edge. Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in......	90	153	119	202	215	366	314	534
Friction Doubled..................		306		404		732		1,168

	5.1 tons. Lever.	Flange.	7.6 tons. Lever.	Flange.	10.2 tons. Lever.	Flange.	12.7 tons. Lever.	Flange.
Test No. 8. Not Lubricated.								
Flat Wrot Bar Iron Bearing on Steel Plate, Area 24 in..........	1,010	2,100	1,384	2,880	1,549	3,220	1,947	4,050
Flat Cast Iron: Contact Area 2⅝x7 in. less 2 openings for waste sponging 115/16x15/16=3¼ in., Area 15⅛ in..........	785	1,630	1,181	2,460	1,403	2,920	1,927	4,010
S. P. Bush Roller..................	290	603	363	750	506	1,053	594	1,234
Test No. 9. Lubricated.								
Flat Wrot Bar Iron Bearing on Steel Plate, Area 24 in..........	638	1,327	732	1,521	917	1,907	1,124	2,339
Flat Cast Iron: Contact Area 2⅝x7 in. less 2 openings for waste sponging 115/16x15/16=3¼ in., Area 15⅛ in..........	380	790	609	1,266	834	1,735	981	2,040

Tests of Center Plates and Side Bearings, P., C., C. & St. L. Railway.

for worn flanges; a reduction of 30 per cent., notwithstanding that the wheels were an average of four years old when bearings were applied, that the car mileage had been increased, that train hauls had become greater, and that the equipment was one year older.

The indications are that the flange wear of 1902 shall be decreased in even greater proportion, as the effect of the side bearings on the service in general approaches its limit.

The service of 52 ore cars equipped with the roller bearings was compared to that of 52 cars with plain side bearings (the car numbers selected at random) for 1900. While no wheels whatever were removed from the 52 cars with the roller bearings, 17 wheels were taken from the cars with plain bearings for having the flanges worn. By comparing 300 ore and flat cars with the automatic frictionless side bearings with 300 cars with plain bearings for 1901, it was found that while 101 wheels were removed for sharp flanges from the cars having plain side bearings, only 16 wheels were removed for having the flanges worn, from those cars equipped with the automatic frictionless side bearings.

The question of the effect of the automatic frictionless side bearings on flange wear alone is presented, because the wear of the wheel flanges can be easily and definitely ascertained, but while the other economies and advantages are equally apparent, they can not be so accurately determined. It will be readily appreciated, however, that this reduction in flange wear shown means an equivalent reduction in rail wear, and a proportionate decrease in the draft of trains, and consequently a reduction in the cost of transportation. Again, the capacity and the life of the car bolsters are increased, and the cost of truck repairs considerably lessened.

H. S. BRYAN, *Master Mechanic.*

CONCLUSIONS.

Attention is called to the reduction in flange resistance by lubrication, the lubricant being a thick grease.

The replies received to the circular of inquiry from 18 members show a variation in distance, center to center, of side bearings and center plates, from 24 in. to 32½ in.

The height of center plates varies from 2½ in. to 7 in.

As to the (4) merits of anti-friction side bearings for relieving the center plate from part of the load, from the replies received from the members it would seem that opinion is about equally divided. Your committee is of the opinion, however, that with a center plate of proper design and material, and a truck and body bolster of sufficient strength, the load can and should be carried on but one bearing point, namely, the center plate.

As to the fifth subject, resistance between wheels and rails, it is the opinion of your committee, and this opinion is substantiated almost unanimously by the replies received from the members, that the use of anti-friction side bearings will diminish this resistance.

Attention is further called to the fact that when side bearings are in contact the pressure against wheel flanges is greater than with center plates alone in contact.

In this connection it might be well to state that your committee has received from one of the manufacturers of anti-friction side bearings an offer to furnish, free of charge, any number of its bearings that may be needed for the purpose of tests against plain bearings. This offer was received too late to be made available for the purposes of this report.

This report is signed by Messrs. B. Haskell (Chairman), H. M. Pflager, W. H. Marshall, T. W. Demarest.

OUTSIDE DIMENSIONS OF BOX CARS.

At the meeting of the American Railway Association, held April 24, 1901, the following principle regarding the construction of box cars was approved:

"That the essential elements of the standard box car require that the height and width be as great as are permitted by the physical limitations of the important railroad clearances and the present established height of loading platforms; that the length be determined by economy in construction, maintenance and operation and the requirements of economical storage."

At the convention of the same Association, held in St. Louis on October 23, 1901, in pursuance of the above principle, a Committee on Standard Dimensions of Box Cars submitted report in which the following resolution was offered for adoption:

"That the dimensions of the standard box car be 36 ft. in length, 8 ft. 6 in. in width, and 8 ft. in height, all inside dimensions. Cross section 68 sq. ft., capacity 2,448 cu. ft. The side door opening to be 6 ft. in width."

On a vote by the roads, the above resolution was adopted, there being but one dissenting vote.

The cross section and longitudinal measurements are the dimensions between lining, the vertical measurements being from top of floor to underside of carline.

The following resolution was adopted:

"That the Master Car Builders' Association be requested to consider and adopt the required external dimensions for the standard box car, based upon the interior dimensions as prescribed by the American Railway Association." . . .

Your committee carefully considered the physical limitations of clearances, etc., of the railroads of the country, bearing in mind the further limitations prescribed for inside dimensions by the American Railway Association and submitted to the members of this Association certain outside dimensions, as follows:

For a box car set on trucks used as standard, where the height from top of rail to top of floor is 4 ft.:

	Feet.	Inches.
Height, top of rail to upper edge of eaves. .	12	6¾
Width at eaves, at above height, maximum	9	7⅜

For a box car set on low trucks, where the height from top of rail to top of floor is 3 ft. 6 in.:

	Feet.	Inches.
Height, top of rail to upper edge of eaves. .	12	¾
Width at eaves, at above height, maximum	9	10

The members of the Association were asked to state whether or not they approved of the above dimensions; if not, wherein they should be modified to meet existing conditions. From the replies to this circular it was found that the exterior dimensions given above were satisfactory to a majority of the roads, but on certain of the trunk lines there were clearance limits which would not permit cars set on low trucks (3 ft. 6 in.) of the cross section given (9 ft. 10 in.) at the height of 12 ft. ¾ in., to pass.

To meet these conditions your committee has decided to modify its original recommendation in this respect, and would suggest 9 ft. 7 in. as the maximum width at eaves at a height of 12 ft. ¾ in., and for the sake of uniformity would also change its original recommendation as regards the width at eaves of cars set on trucks with 4 ft. in height to top of floor, from 9 ft. 7⅜ in. to 9 ft. 7 in., thus giving a standard width for cars of either height. . . .

The inside measurements having been established by the American Railway Association, and the outside dimensions being confined to the limiting clearances of the leading trunk lines, the committee has carefully considered the various forms of framing which have been submitted to it in order that the best possible construction may be had between these limitations, and it submits for your consideration what it believes to be a substantial box-car framing, which will carry the loads required and make a strong car in every particular.

Your committee would recommend that on all cars built to these dimensions the words and letters "Standard, 12 ft. 6¾ in. by 9 ft. 7 in." be stenciled in letters not less than 3 in. in height on the end fascia boards.

Your committee would also recommend that the dimensions for inside measurements of box cars as prescribed by the American Railway Association be adopted as the standard of this Association. . . .

Side Door.

The American Railway Association has recommended that the side door opening for the above car be 6 ft.

Your committee finds that there is much objection from the mechanical standpoint to the 6-ft. width of door opening for the following reasons:

1. It weakens the framing of the car both on the sill and plate lines.

2. The increased size in the width and height of the side door makes it extremely difficult to construct a door which will remain straight and prevent binding on the sides of the car, which has always been found to be very objectionable and destructive to both siding and door because of the indifferent manner in which our doors are manipulated at the freight houses.

3. On the grain carrying roads it would necessitate the use of a grain door so heavy and large that it would be impracticable for one man to handle it; additional complications would be entailed in its construction, and it would necessitate carrying in stock additional thickness of lumber in such size as not to be readily obtainable.

Your committee, while it has recommended for adoption as standard external dimensions which it believes adequate for strength for cars of the inside dimensions adopted by the American Railway Association, and has presented for your consideration certain details of car framing to meet these external dimensions, does not recommend these latter details for adoption. It believes that the time is now here for the adoption by this Association of a standard box-car framing, and it would recommend that a committee be appointed to propose for adoption as standard, at our next convention, a system of framing for box cars with inside and outside dimensions as above.

A brief summary of the recommendations herein mentioned is as follows:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 in. wide and 8 ft. high, be submitted to letter ballot for adoption as standard.

2. For box cars on high trucks (4 ft. to top of floor):

	Feet.	Inches.
Height, top of rail to upper edge of eaves. .	12	6¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

3. For box cars on low trucks (3 ft. 6 in.):

	Feet.	Inches.
Height, top of rail to upper edge of eaves. .	12	¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard 12 ft. 6¾ in. by 9 ft. 7 in." be stenciled in 3-in. letters on the end fascia boards on all cars built to these dimensions.

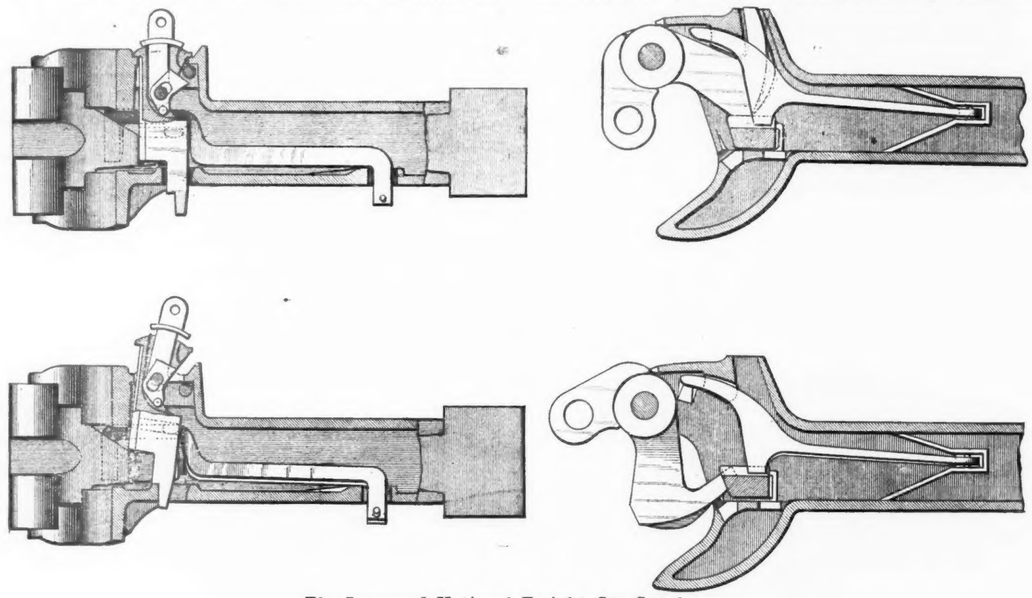
5. That a committee be appointed to report at the next convention a detailed form of framing for box cars, for adoption as standard.

This report is signed by Messrs. C. A. Schroyer (Chairman), G. W. Rhodes, W. P. Appleyard, Jos. Buker, J. N. Barr.

The Improved National Freight Coupler.

The improved coupler that is now being made by the National Car Coupler Co. is shown in the accompanying illustrations. The improvements are due to Mr. J. A. Hinson, President of the company, the features constituting these improvements being quite apparent from the engravings. They consist of a knuckle-opener and an auxiliary lock, or a lock for the lock.

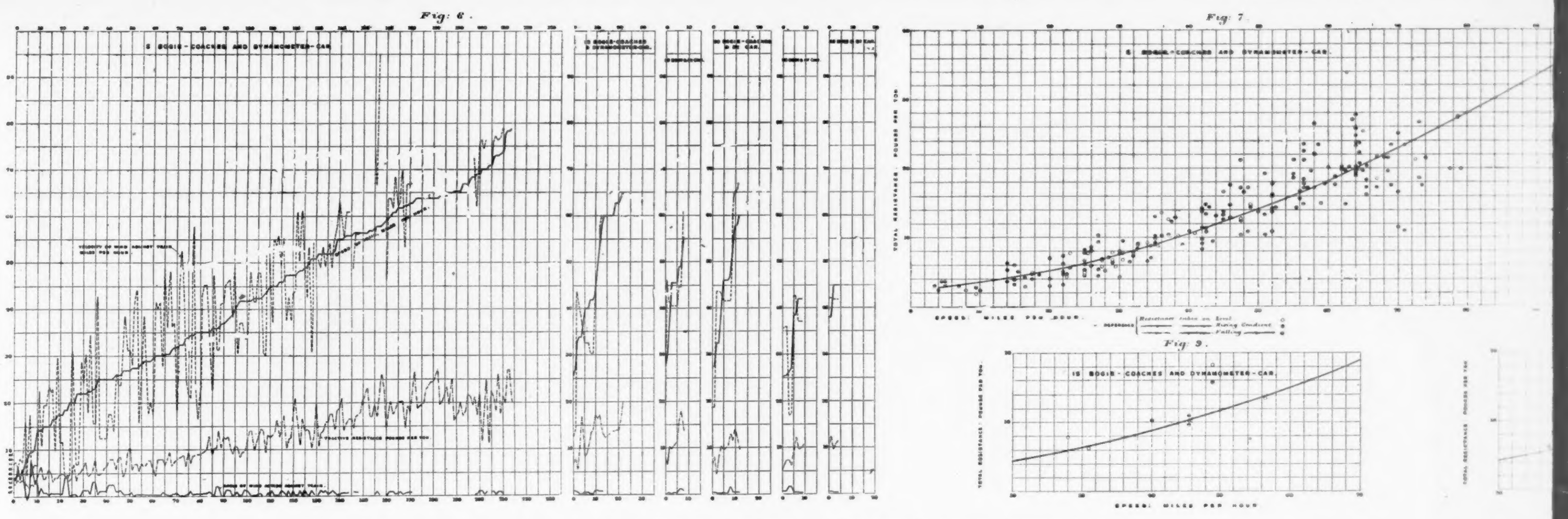
The engravings show the lock in two positions; the upper view it is closed, with the auxiliary lock in place; the lower is the uncoupling position. The knuckle lock has an opening in the top, having a depth equal to about half the length of the lock. A pin passes through the lock horizontally near the bottom of the opening, pivoting the movable head which fits in the hollow portion, and permitting a slight vertical motion of the head by means of slots in the walls of the opening. It will be seen that the auxiliary lock is also slotted and is pivoted in such a way that vertical motion of the movable head draws this lock back, permitting the coupler lock to be lifted. The lower view shows the small shoulder at the bottom of the lock resting on the rim of the opening through which it extends in the closed position. This feature permits the lock to be set preparatory to a separation of the cars without having to make use of the bracket at the corner of the car. The lock having been set in this manner, the cars can be uncoupled and coupled again without further attention from the brakeman.



The Improved National Freight Car Coupler.

The knuckle-opener, the form and position of which are shown very clearly by the figures, is a peculiar-shaped casting extending from the head back into the shank of the coupler, the rear end having a bend at right angles, which extends through an opening in the lower wall of the bar and has a pin inserted to prevent it from jumping or being forced out. An extension on the opener engages in a suitable slot in the lock. The vertical sections show the front of the opener to bend upward to the height of this lock-slot, extend horizontally and bend downward again as a leg. The front end of the opener is supported on a lug cast on the wall of the head; lifting the lock causes the leg to rotate, kicking the knuckle open. Ribs are cast on the inside of the bottom wall of the shank, which guide the rear end of the knuckle-opener to the opening through which it is designed to project. Should the drawbar be torn from its fastenings, and the lock chain break, this extension of the knuckle-opener will come in contact with the carrier-iron, preventing the bar from falling on the track, which is a desirable safety feature.

The coupler is made throughout of open-hearth steel, with a 1⅝-in. pivot pin. The knuckle-opener can be removed and the coupler used without it if desired. Other



Figs. 6 to 10, Plate 2.—Tractive Resistance Experiments.

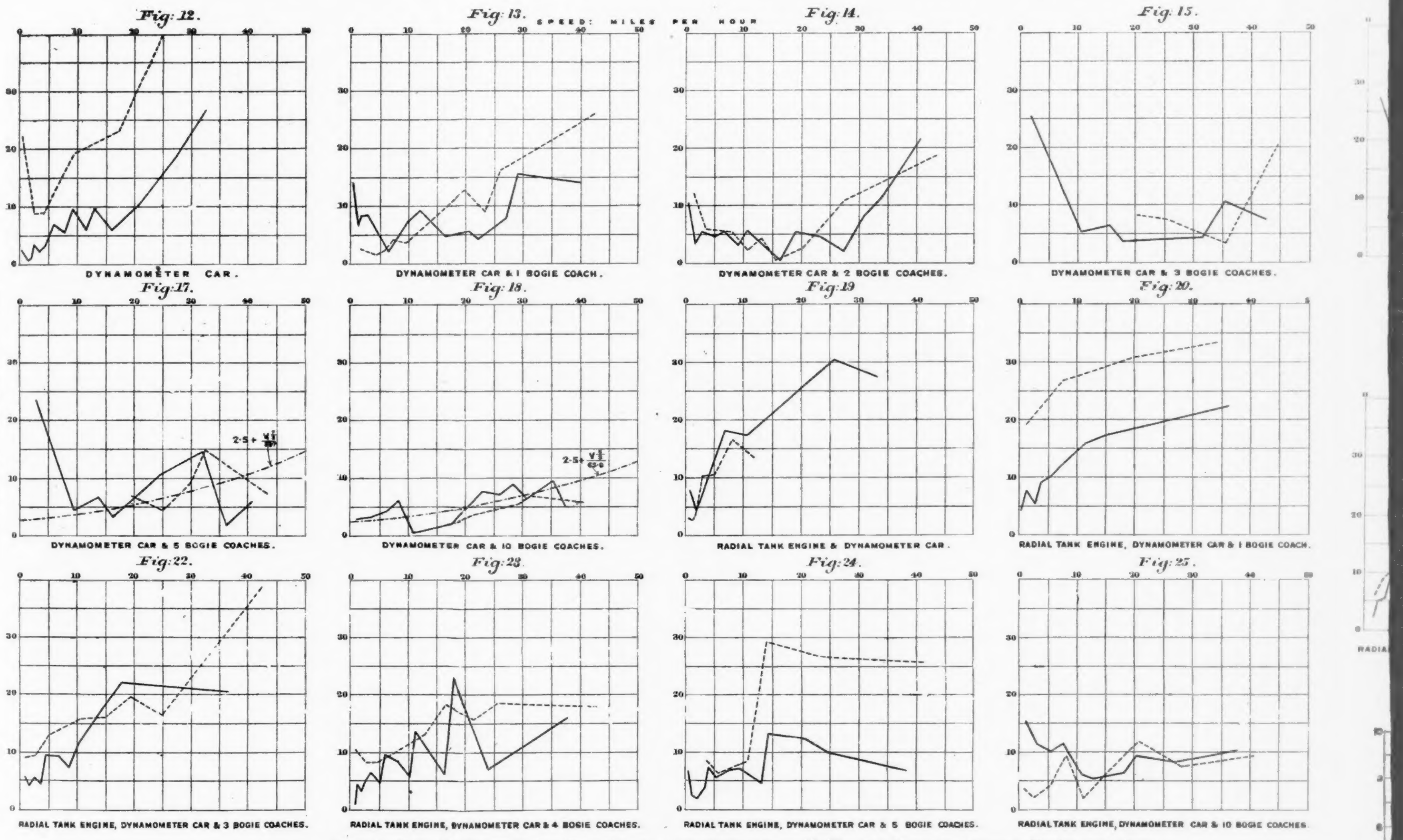


Plate 3—Figs. 12-18.—Coasting Experiments, Cars Only. Figs. 19-25.—Coasting Experiments, Engine and Cars.

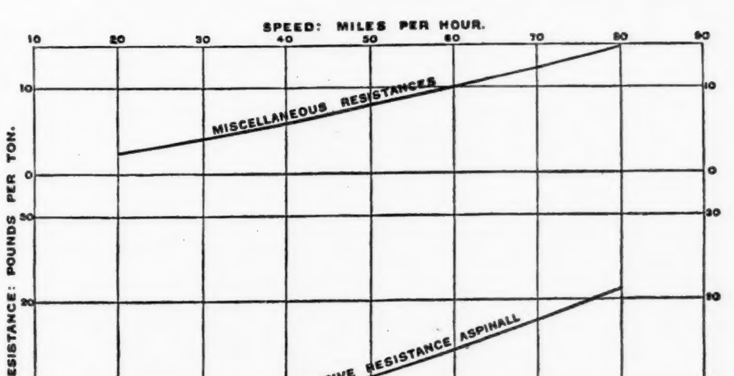


Fig. 36.—Component Parts of Train Resistance.

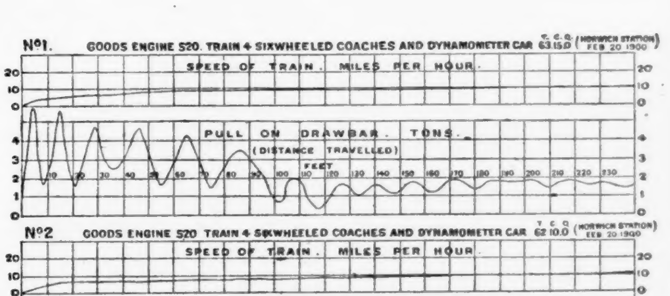
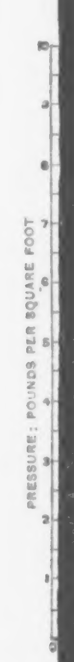
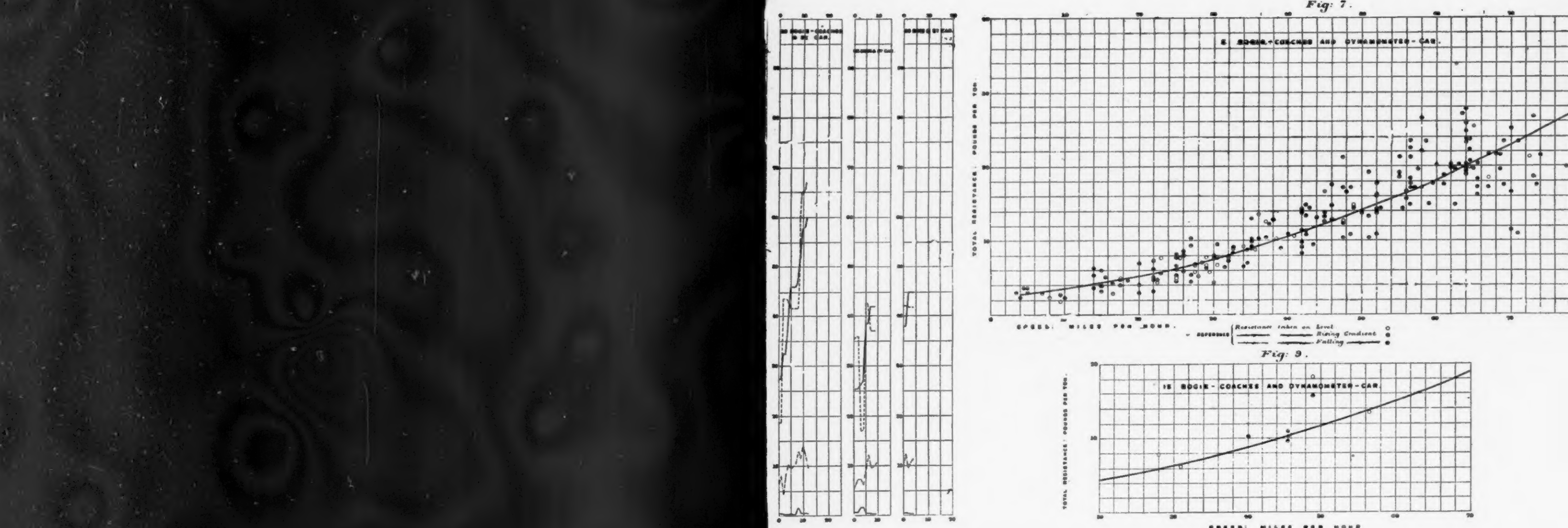


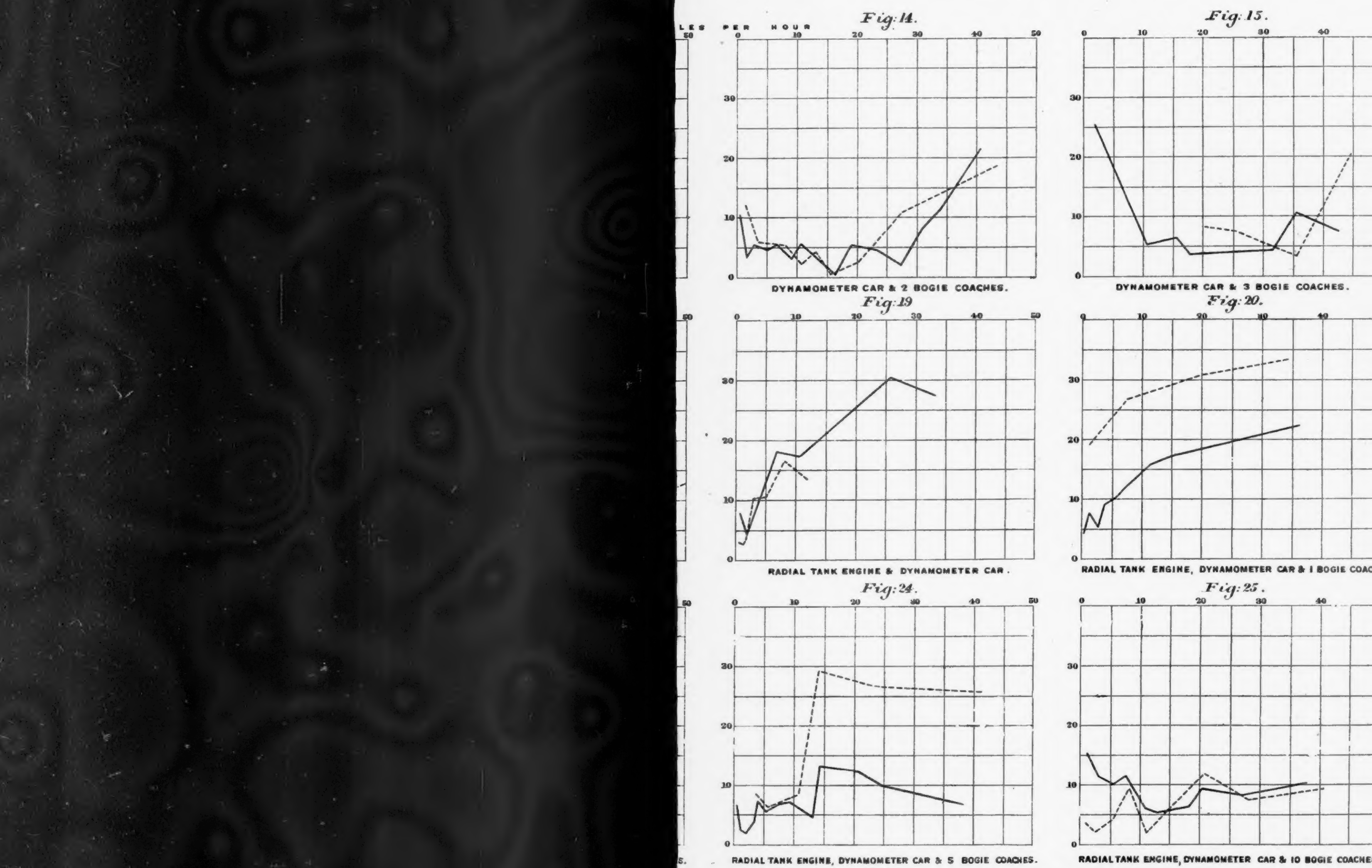
Fig. 5.—Acceleration Curves.



DIAGRAMS ILLUSTRATING MR. J. A. F. ASPINALL'S PAPER



to 10, Plate 2.—Tractive Resistance Experiments.



nts, Cars Only. Figs. 19-25.—Coasting Experiments, Engine and Cars.

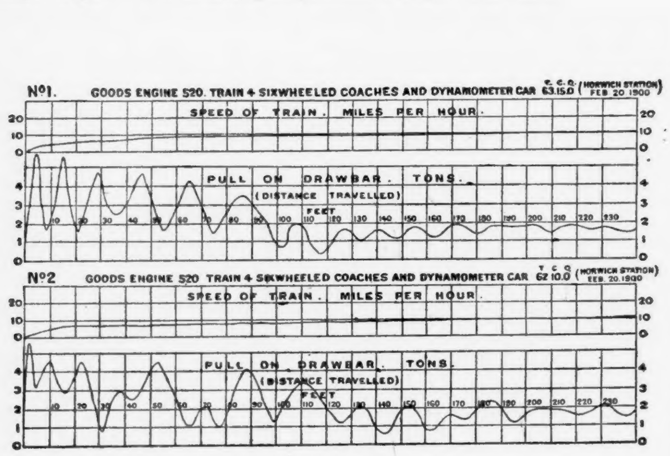
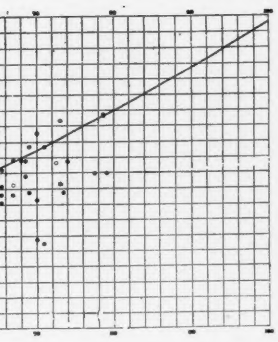


Fig. 5.—Acceleration Curves.

DIAGRAMS ILLUSTRATING MR. J. A. F. ASPINAL



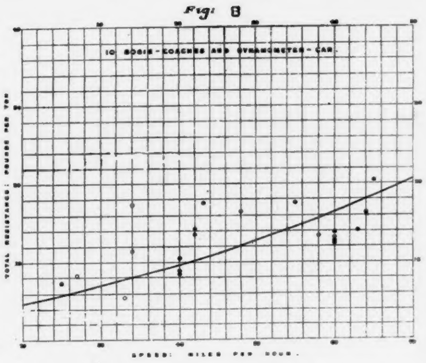


Fig: 8

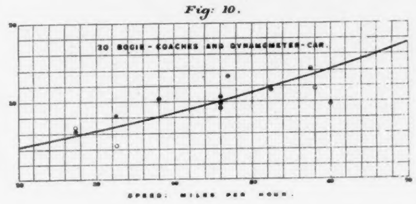


Fig: 10.

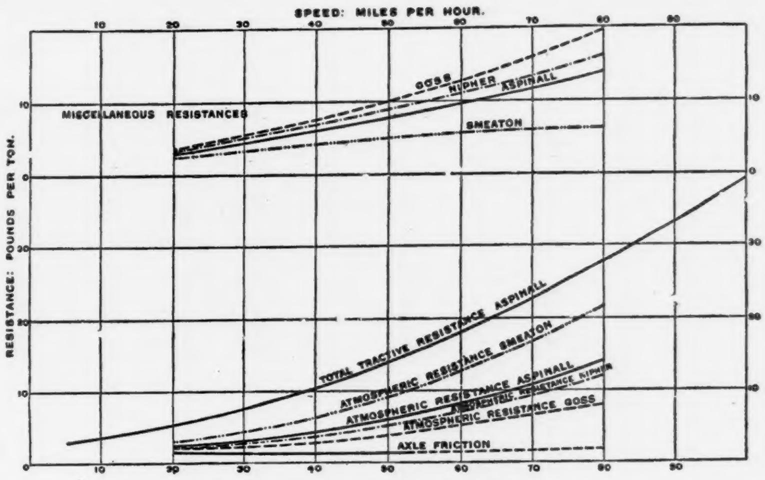
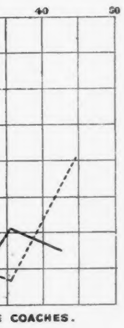


Fig. 34.—Component Parts of Train Resistance.



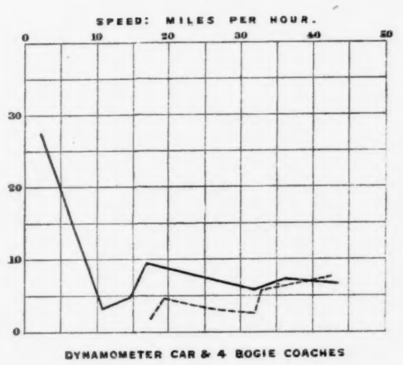


Fig: 16.

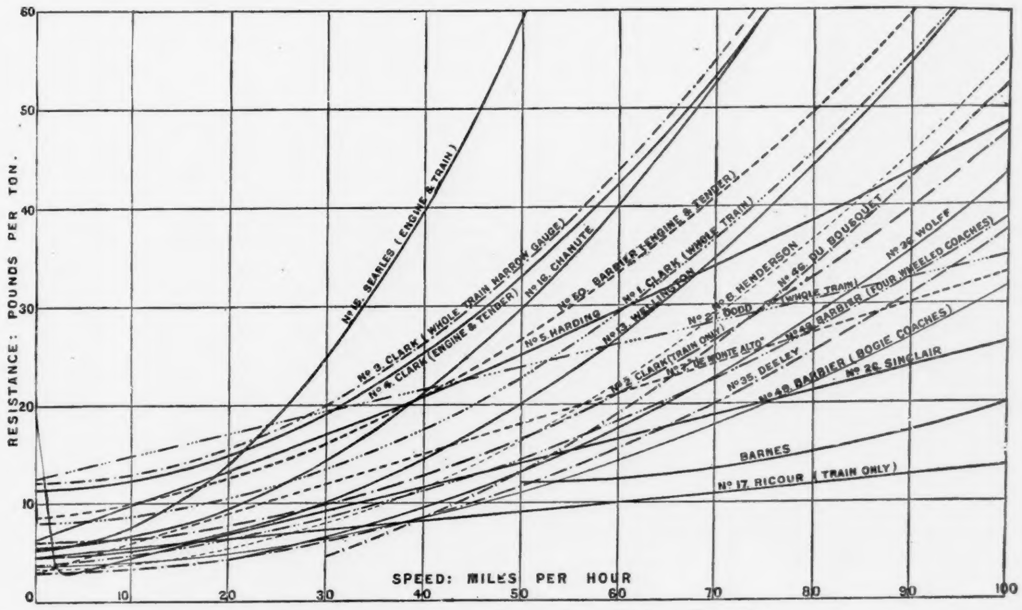


Fig. 39.—Train Resistance Curves from Various Formulas.

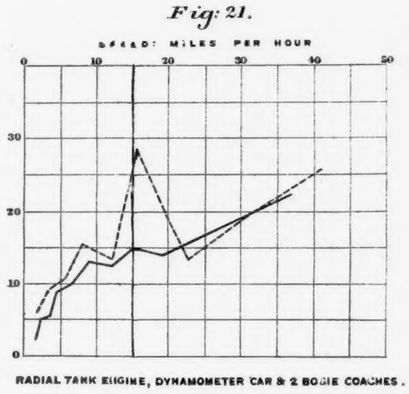


Fig: 21.

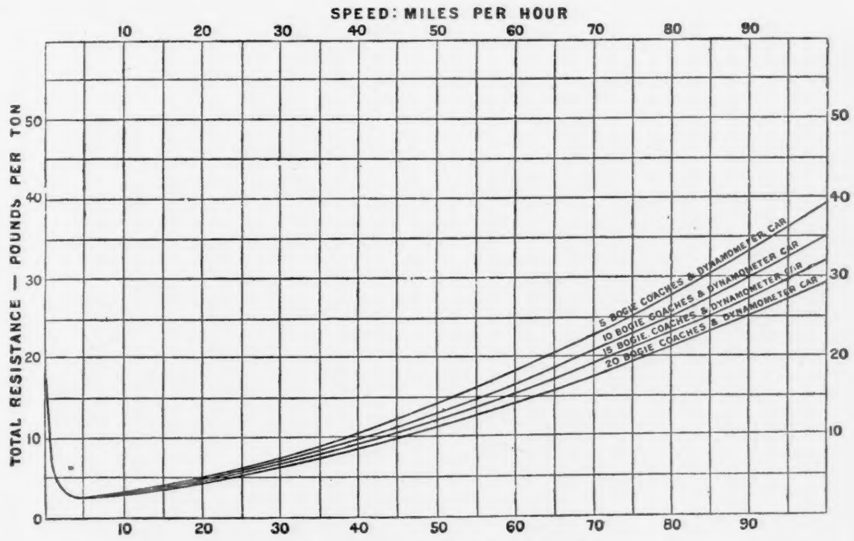


Fig. 11.—Curves Plotted by Formula.

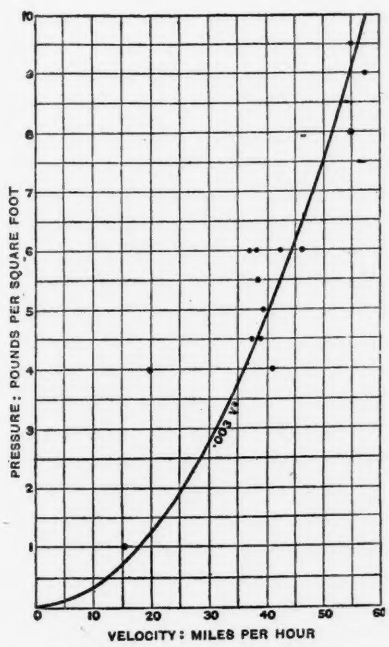


Fig. 32.—Observed Wind Pressures.

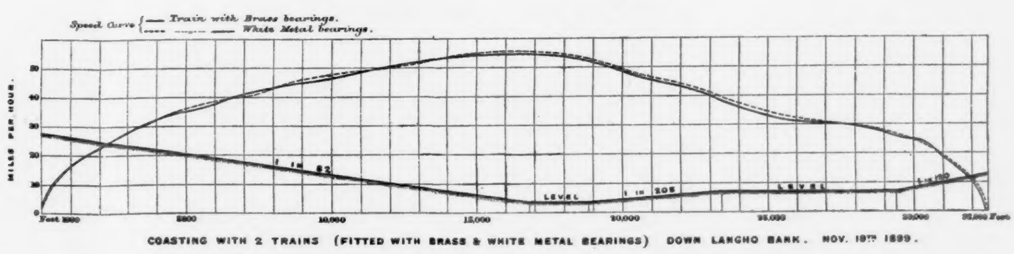
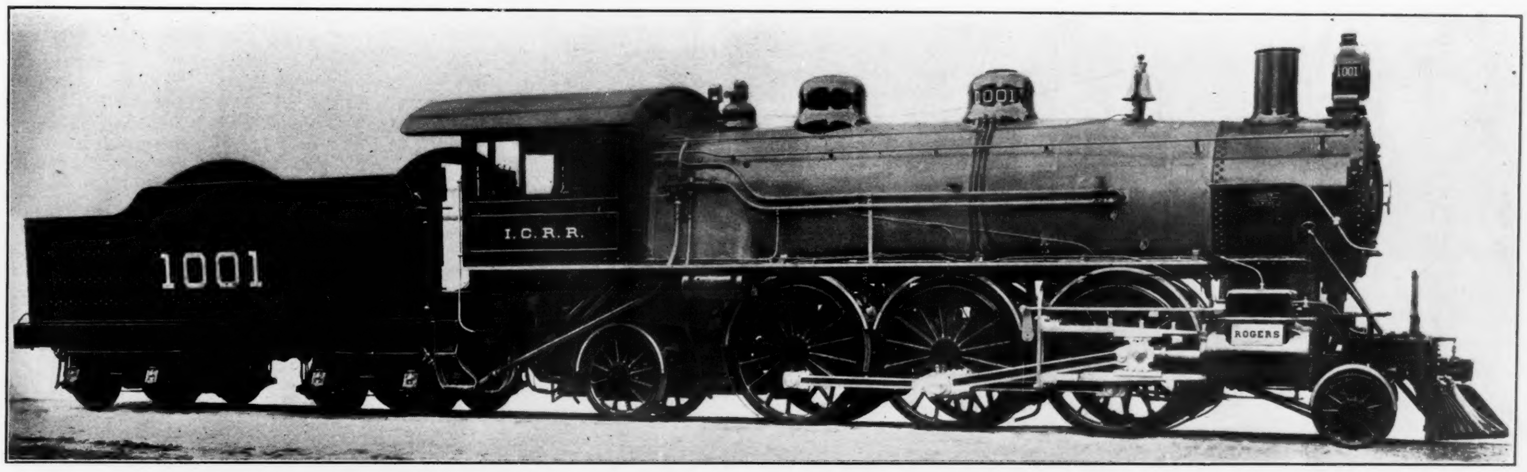
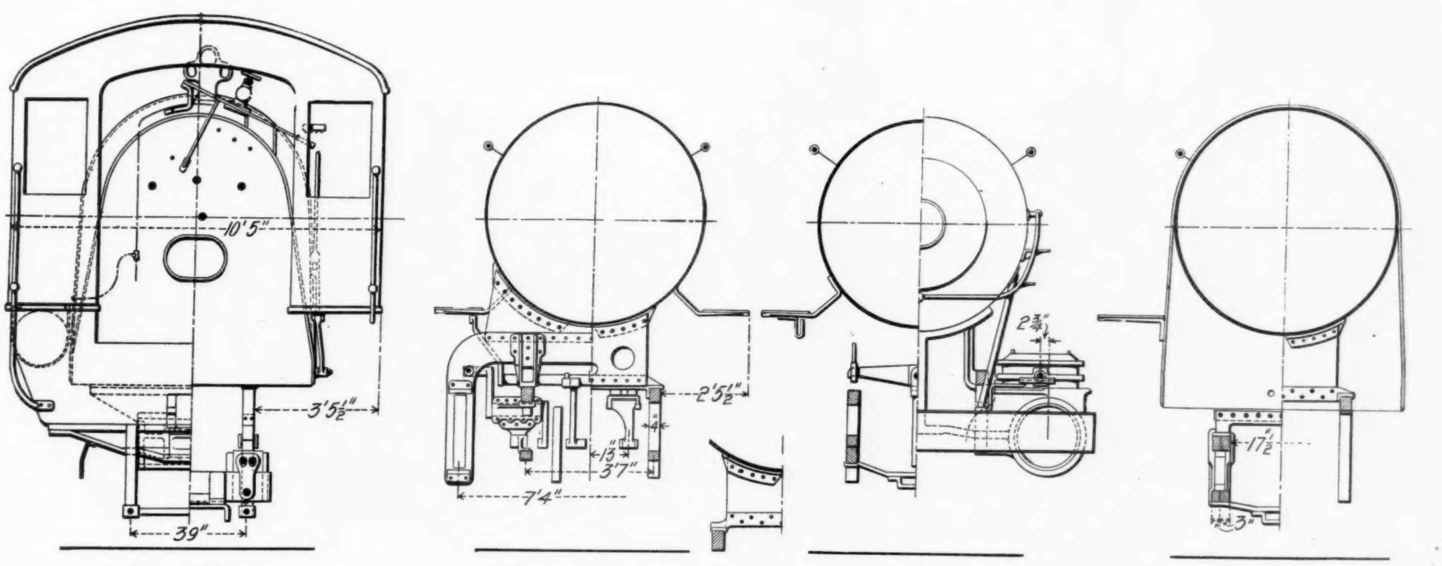


Fig. 33, Plate 3.—Axle Friction.

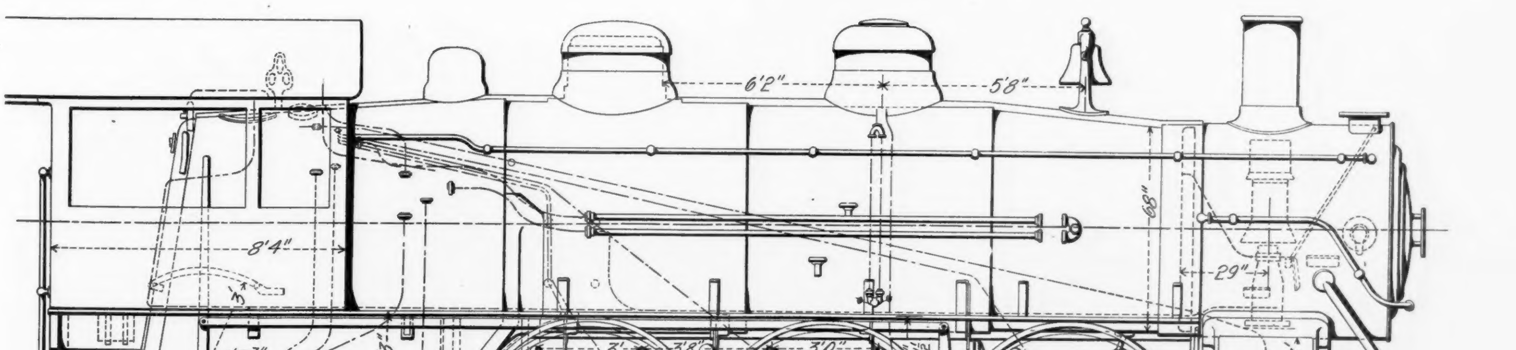
T. ASPINALL'S PAPER ON TRAIN RESISTANCE.



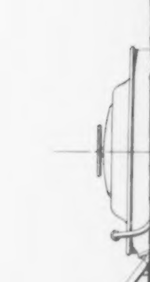
Rogers Prairie Type Engine for the Illinois Central Railroad.



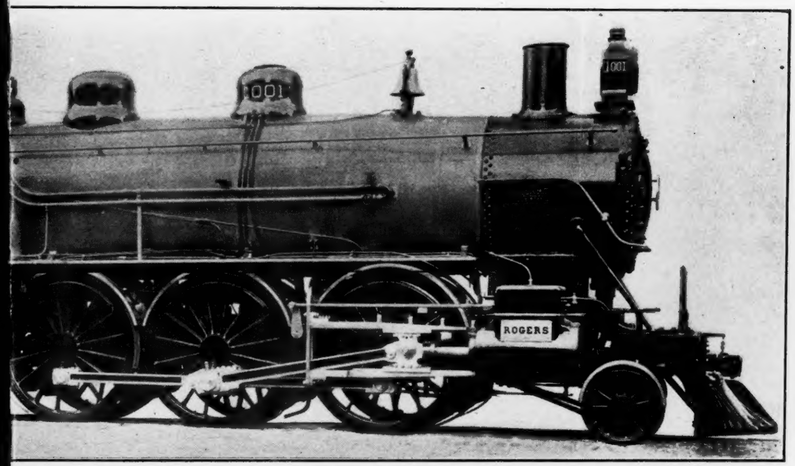
Cross Sections of Prairie Type Engine.



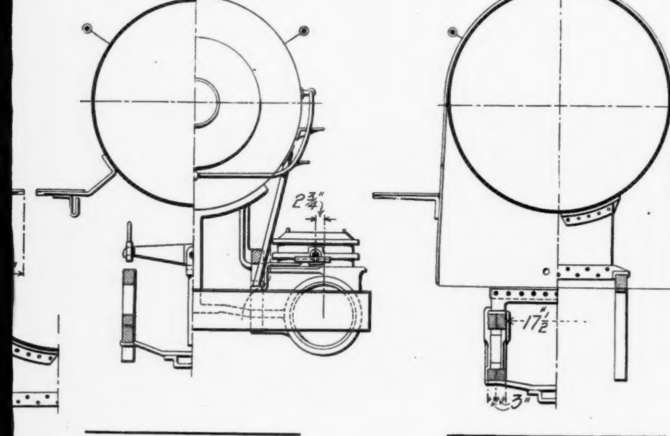
General Elevation of Illinois Central Prairie Type Engine.



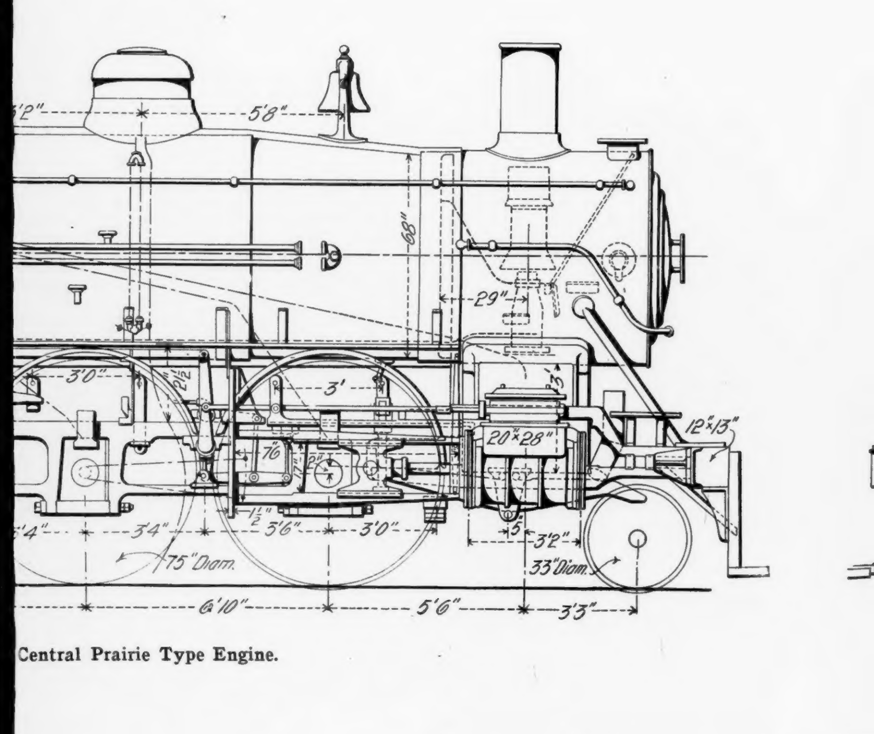
COMPETITIVE LOCOMOTIVE TYPES FOR THE ILLINOIS



for the Illinois Central Railroad.



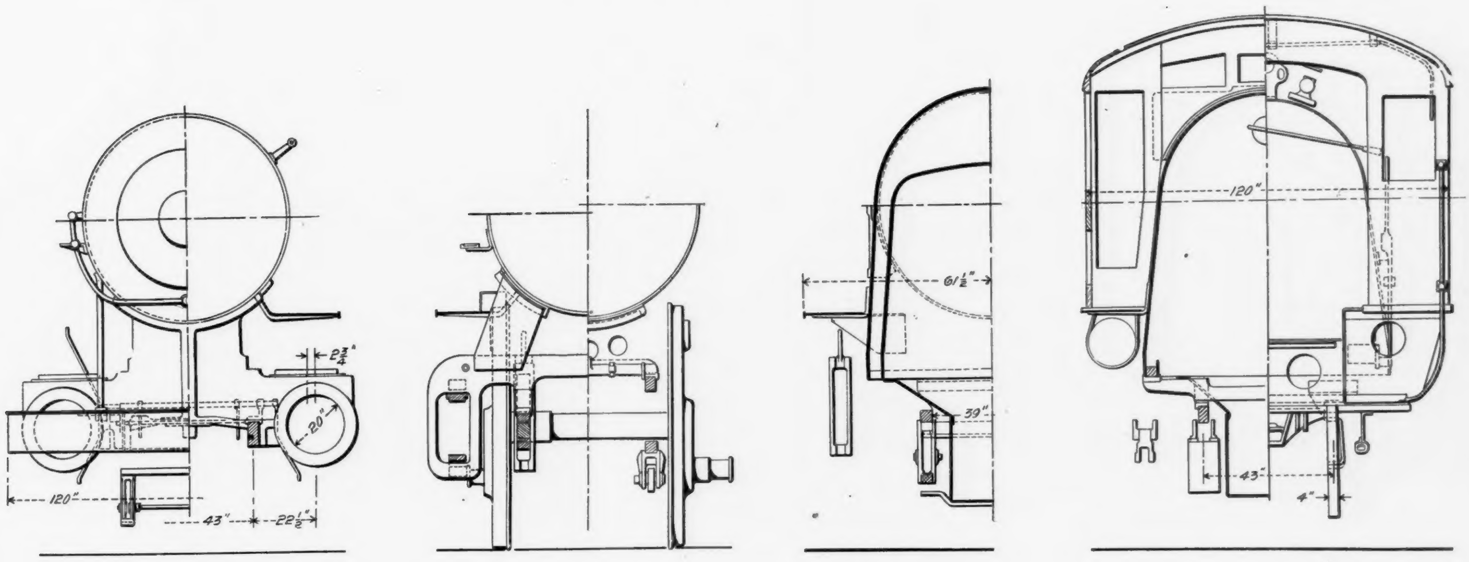
Prairie Type Engine.



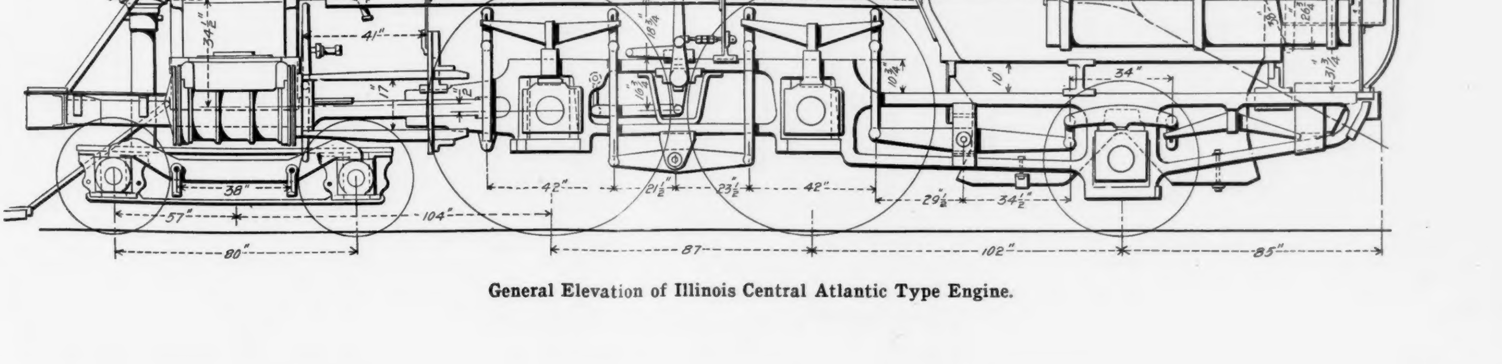
Central Prairie Type Engine.

COMPETITIVE LOCOMOTIVE TYPES FOR THE

Baldwin Atlantic Type Engine for the Illinois Central Railroad.



Cross Sections of Atlantic Type Engine.



General Elevation of Illinois Central Atlantic Type Engine.

ES FOR THE ILLINOIS CENTRAL RAILROAD.

tails of these experiments should enable the results indicated by the author to be criticized and checked in such a way as to eliminate any inaccurate statements.

The author has to express his acknowledgments to Mr. H. Fowler, Assoc. M. Inst. C.E., and to Mr. A. C. Rogerson for their assistance in the conduct of the experiments, and in the preparation of the Paper.

In conclusion he wishes to draw attention to the careful experiments on train-resistance made by the officials of French railroads, which have been published from time to time. The formulas given by various authorities for tractive resistance are tabulated in an appendix, with references to the sources of information. Curves corresponding to some of these formulas, for speeds up to 100 miles per hour, are shown in Fig. 39.

Master Car Builders' Reports.

(*Continued from page 458.*)

SIDE BEARINGS AND CENTER PLATES.

Your Committee on Side Bearings and Center Plates was continued from last year, with instructions to report on

1. A design of center plate, with a view to adopting dimensions for standards or recommended practice.
2. The location of side bearings.
3. Uniform relation between center plate and side bearing.
4. The merits of anti-friction side bearings for relieving the center plate from part of the load.
5. Will the use of anti-friction side bearings diminish the resistance between the wheels and rails.

Center Plates.

Your committee has endeavored to obtain data which would enable it to present for your consideration a form of center plate for adoption as standard. Under the direction of Mr. Demarest a series of tests has been conducted of different forms of center plates and side bearings, and the results, as far as they have been completed, are given herein. . . .

The object of the test with center plates was twofold; first, to ascertain the best metal for center plates; second, to define, if possible, the best shape. In making the test, two male center plates were bolted on the opposite sides of one end of a lever, each male center plate in turn engaging in a female center plate; the entire construction being forced together by a hydraulic press, from which were obtained total pressures ranging from 15.3 tons to 40.8 tons. The end of the lever in turn was moved through an arc by means of an air cylinder; an indicator and reducing motion being attached, in order to ascertain the amount of work done in turning the male plates in the female plates under the different pressures obtained.

The result of these tests is shown in detail, graphically and in statement form, on data sheets. The tests for side bearing friction were made in practically a similar manner, with the exception that the lever was pivoted at a point which would correspond to the average distance of side bearings from king bolt.

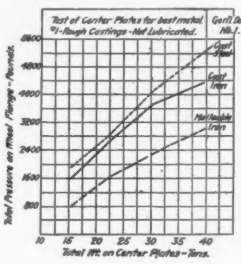
In order to ascertain, if possible, the best material for center plates, a number of plates were made as per plate "A," of three different materials: cast iron, malleable iron and cast steel. We were unable to obtain pressed steel plates of equivalent area or shape. The area, generally, of the plates was 100 sq. in.

Test No. 1 of this series was made with the castings as they were received from the manufacturers, with no dressing or cleaning whatever. The cast steel, which gave the highest resistance, was extremely rough, had thick scale, fused patches on the surfaces, lumpy fillets, fins around the core holes, etc. The cast-iron was not much better, and as a consequence the friction is close to the steel. The malleable plates were very smooth, clean castings, and gave a very much lower resistance. The results of this test show the difference in friction or resistance due to the varying smoothness of the surface.

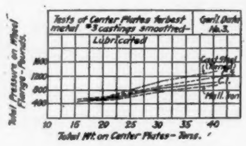
Test No. 2 of this series was made by grinding the surfaces with an emery wheel, and chipping off fins and lumps in the fillets. This attention is assumed to be about as much dressing as it would be practicable to give the plates in actual practice. The scale was not removed, the casting simply being made smooth. In this test the resistance of the cast-iron and malleable-iron plates varies very little, if any, from the resistance obtained in the first test. The resistance of the cast-steel plates, however, has fallen most materially. The large drop in resistance of the steel plate was thought to be due to the crumbling of the thick, porous scale into a powder, which acted as a lubricant. This view was sustained by the fact that in the next test, with this same plate lubricated, there was but little further drop in the friction, the powdered scale in the latter instance preventing good lubrication.

In test No. 3 the same plates were taken as in previous tests and lubricated. The results of the lubrication are shown very conclusively in the very great drop in resistance.

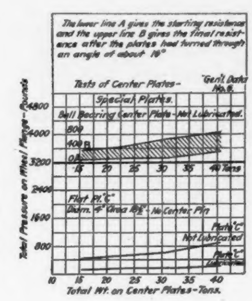
In order to ascertain, if possible, if the low friction of the cast-steel in test No. 2 was due to the powdering of the scale, the cast-steel plates were put in a lathe and the scale turned off and surfaces made smooth. They were again tested and the resistance was found to be lower than before the scale was removed from the surface. The effect of lubrication in test No. 2 practically eliminates the effect of the metal, as the plates of the different materials, when lubricated, have practically the same resistance.



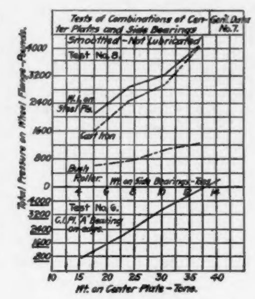
Test No. 1.



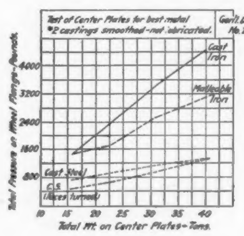
Test No. 3.



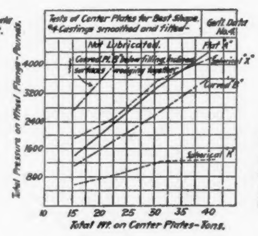
Special Tests.



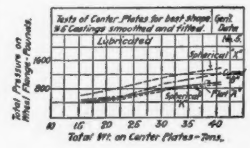
Tests Nos. 6 and 8.



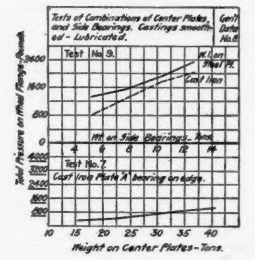
Test No. 2.



Test No. 4.

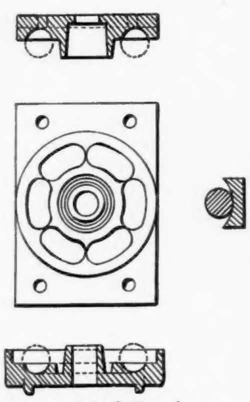


Test No. 5.



Tests Nos. 7 and 9.

The object of the second series of tests was to determine the effect of the shape of the contact surfaces. Having found the effect of rough castings in the first series of tests, all plates were smoothed and fitted. All plates were made of the same metal, cast-iron, and all except that designed by Mr. Klohs, for the Master Car Builders' Committee, had 100 sq. in. area of contact surfaces; the latter plate had 76 sq. in. The results from test of flat plate in series No. 1 were taken for comparison with the curved and spherical plates in series No. 2, and it was expected that the flat plate would have the lowest friction on account of the tendency of the inclined surfaces of the other plates to wedge together. The results obtained from the tests do not at all confirm the theory. They do not show the superiority of the flat plate, and they do show an abnormally low friction for the plate designed by Mr. Klohs. The curves, Nos. 4 and 5, show very plainly, as in the first series of tests, the good effect of lubrication, and indicate that when well lubricated the shape of the plate does not materially affect the resistance. The tests with the lubricant do show, however, that the resistance of the flat plate is lower than the spherical plate "X" and curved plate "B," and about the same as the Klohs plate. We can see nothing in the contour of the Klohs plate which would tend to produce lower resistance than we have obtained from the spherical plate "X." The unsuspected results are due, we believe, to the condition of the surfaces of the plates. The flat plate required but little grinding and fitting to give it a good bearing. The spherical and curved plates, however, fit badly in the rough, and required hard grinding, filing, etc., to bring them to a reasonable fit. The final condition of the surfaces was, therefore, very much better with the spherical and curved plates than with the flat plate. The Klohs plate was ground especially hard on the steeper slopes, and brought down to a good fit in the bottom, which is nearly flat. It is very probable that this plate was ground too hard on the outer ring, concentrating the weight on the inner ring, which is nearly flat and of much smaller diameter, with the resultant low resistance. Further tests in this series will be made by placing the plates in a lathe and fitting them carefully over their entire surfaces, removing all scale and testing them dry and lubricated, in order to settle definitely the conflicting results.

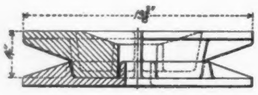


Standard Ball Bearing Center Plate.
Plate P.

Further tests in this series were made with special plates, namely, a small experimental plate "C" with flat surfaces, designed to be used without a center pin, and having a face only 4 in. in diameter, with the idea that it might be possible to use such a plate in conjunction with a roller or other low friction side bearings to assist in maintaining the balance of the car. It was desired to have this plate chilled, as only a very hard surface could stand the heavy pressures. The plates were received soft from the foundry, however. The friction of this plate is very low, but cut badly both when dry and when lubricated; the cutting in both instances taking place in the center of the plate. The second special plate tested in series 3, as shown by test No. 6, was the ball-bearing center plate used by the P. & L. E. R. R.. This plate gave the lowest resistance recorded under the conditions. The balls lie in pockets, which, in length, are about twice the diameter of the ball, and enough larger in width than the diameter to allow the ball to roll freely. The bottom of these pockets curves upwards at the ends, so that the ball begins to roll up hill as soon as it leaves the central position, and as the slope of the pocket is curved, the resistance of the plate to revolution increases as the ball rolls up the slope. The cards taken in this test show a gradually ascending line to a point where the ball seems to lock and stop rolling; the top plate then slides on the balls. The starting and final resistance is shown in tables and on curves for each pressure.

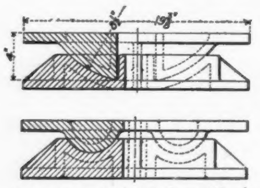
The remaining series of tests were for the purpose of ascertaining, if possible, the combined effect of the center plates and side bearings, as when a car rolls or tips in passing around a curve, and bears on both the center plate and the side bearing. The flat plates "A" were held apart on their lower edges by spreaders, and inclined at an angle equivalent to closing a three-eighths inch clearance, with side bearings 28 in. from the center. The pressure on the back of the plates being uniform, half the weight was taken by the spreaders and half the weight by the edges of the plates. The resistance shown for the plates was therefore doubled to make it comparable with the standard weights used with other tests. The results thus derived are about the same as with the plate bearing on full surface in first series.

The side bearings were tested under comparatively low pressures of from 5 to 12 tons total. It was found impossible to exceed these pressures owing to the fact that the apparatus would lift from the floor. The results of this series show also the effect of good lubrication, and also show that it is from the side bearings that most of the flange resistance is derived. The roller side bearing gives the best results, as was obtained from the roller center plate. All tests, both of center plates and side bearings, show the desirability of thorough lubrication, the castings to be smooth, but scale allowed to remain



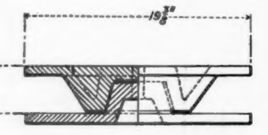
Area of Contact Faces 100 sq. ins.

Plate A.



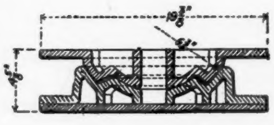
Projected Area Contact Surfaces 100 sq. ins.

Plate B.



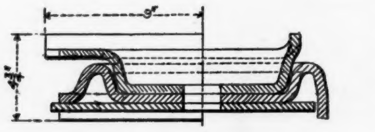
Chilled Contact Surfaces 4" diam.

Plate C.



Designed by Mr. Klohs, Area Contact Surface 76.7 sq. ins.

Plate K.



Pressed Steel Center Plate. Area Contact Surface 46 sq. ins.

Plate S.

on. A thick grease, furnished by the Galena Oil Company for the purpose, was used for lubrication. It is impossible to say how long the grease would last in service. The ball plates and roller side bearings gave very good results, although the ball center plate was badly cut in the upper groove by locking of balls in the pockets. Further, with the larger plates, that is, all plates with the exception of small flat plate "C," no cases of cutting, even under the pressures used, were experienced when there was a good bearing over the entire surface.

It will be noted in the statements that the resistance of the plate to turning is reduced to the wheel flange. We regret that our tests have not been comprehensive enough to permit us to make definite recommendations as to minimum contact area of plates under definite loads, the shape of the plate, or the material from which it should be made. The machine used was rather crude and it is being redesigned with the idea of carrying these tests to a conclusion.

NOTE: *The columns headed Lever and Flange show pull at the end of Lever and pressure on Wheel Flange.*

Series No. 1. For Best Metal— Test No. 1.—Tough Castings. No Lubricant.

Loads.	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Flat Plate "A" Cast Iron, Area 100 in.	973	1,577	1,637	2,650	2,300	3,725	2,548 (39.6 tons.)	4,330
Flat Plate "A" Malleable Iron, Area 100 in.	464	788	957	1,627	1,353	2,300	1,766 (40.1 tons.)	3,000
Flat Plate "A" Cast Steel, Area 100 in.	1,120	1,903	1,676	2,847	2,424	4,125	3,166	5,390

Test No. 2.—Castings Smoothed. No Lubricant.

Loads.	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Flat Plate "A" Cast Iron, Area 100 in.	838	1,420	1,375	2,337	1,995	3,390	2,605 (40.1 tons.)	4,425
Flat Plate "A" Malleable Iron, Area 100 in.	851	1,448	1,012	1,722	1,474	2,503	1,861	3,161
Flat Plate "A" Cast Steel, Area 100 in.	424	720	539	916	675	1,147	798	1,357

Test No. 3.—Castings Smoothed. Lubricated.

Loads.	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Flat Plate "A" Cast Iron, Area 100 in.	257	437	336	571	493	838	605	1,029
Flat Plate "A" Malleable Iron, Area 100 in.	273	464	310	526	442	753	559	948
Flat Plate "A" Cast Steel, Area 100 in.	303	515	369	627	528	898	691	1,174

Series No. 1 For Best Metal—

Loads.	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Test No. 12.—Castings Faced and Fitted in Lathe. No Lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.								
Flat Plate "A" Malleable Iron, Area 100 in.								
Flat Plate "A" Cast Steel, Area 100 in.	279	474	391	665	576	979	805	1,369
Test No. 13.—Cstgs Faced & Fitted in Lathe. Lubricated.								
Flat Plate "A" Cast Steel, Area 100 in.	257	437	387	657	614	1,043	785	1,335

For Best Shape—

	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Test (Extra)—Plates smoothed but not fitted; not bearing in bottom but wedging on the inclined surfaces.								
Curved Plate "B" Cast Iron, Area 100 in.	1,734	2,947	2352	3,995				
Test No. 4. Cstgs Smoothed and Fitted. No lubricant.								
Flat Plate "A" Cast Iron, Area 100 in.	838	1,420	1,375	2,337	1,995	3,390	2,605 (40.1 tons.)	4,425
Spherical Plate "X" Cast Iron, Area 100 in.	1,131	1,923	1,463	2,485	2,110	3,587	2,517	4,275
Klohs Spherical Plate "K" Cast Iron, Area 76 in	347	590	495	842	724	1,230	770	1,309
Curved Plate "B" Cast Iron, Area 100 in.	660	1,122	1,073	1,824	1,564	2,660	2,132 (39.6 tons.)	3,621
Test No. 5. Castings Smoothed and Fitted. Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in.	257	437	336	571	493	838	605	1,029
Spherical Plate "X" Cast Iron, Area 100 in.	358	609	497	845	680	1,155	827	1,407
Klohs Spherical Plate "K" Cast Iron, Area 76 in	255	433	338	575	468	796	570	968
Curved Plate "B" Cast Iron, Area 100 in.	289	491	340	578	563	956	737	1,254

Series No. 3. Special Plates—

	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Test No. 10. Not lubricated. Plate "C" Smoothed.								
Flat Plate "C" Diam 4 in. No Center Pin, Area 12½ in.	246	418	295	501	356	605	534	906
P. & L. E. Ball Bearing: Resistance at beginning of movement	46	78	68	115	68	115	183	311
Resistance at end of movement	200	340	245	416	387	658	617	879
Test No. 11. Lubricated.								
Flat Plate "C" Diam 4 in. No Center Pin, Area 12½ in.	64	109	81	138	86	146	127	216

Series No. 2. Combined Center Plates and Side Bearings—

	15.3 tons. Lever.	15.3 tons. Flange.	22.5 tons. Lever.	22.5 tons. Flange.	30.6 tons. Lever.	30.6 tons. Flange.	40.8 tons. Lever.	40.8 tons. Flange.
Test No. 6. Plate Bearing on edge. Not Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in.	218	371	570	968	1,047	1,780	1,531	2,601
Friction Doubled		742		1,936		3,560		5,202
Test No. 7. Plate Bearing on edge. Lubricated.								
Flat Plate "A" Cast Iron, Area 100 in.	90	153	119	202	215	366	314	534
Friction Doubled		306		404		732		1,168

Test No. 8. Not Lubricated.

	5.1 tons. Lever.	5.1 tons. Flange.	7.6 tons. Lever.	7.6 tons. Flange.	10.2 tons. Lever.	10.2 tons. Flange.	12.7 tons. Lever.	12.7 tons. Flange.
Flat Wrot Bar Iron Bearing on Steel Plate, Area 24 in.	1,010	2,100	1,384	2,880	1,549	3,220	1,947	4,050
Flat Cast Iron: Contact Area 2⅝x7 in. less 2 openings for waste sponging $1^{15}/_{16}$x$^{15}/_{16}$=3¼ in., Area 15⅛ in.	785	1,630	1,181	2,460	1,403	2,920	1,927	4,010
S. P. Bush Roller	290	603	363	750	506	1,053	594	1,234

Test No. 9. Lubricated.

	5.1 tons. Lever.	5.1 tons. Flange.	7.6 tons. Lever.	7.6 tons. Flange.	10.2 tons. Lever.	10.2 tons. Flange.	12.7 tons. Lever.	12.7 tons. Flange.
Flat Wrot Bar Iron Bearing on Steel Plate, Area 24 in.	638	1,327	732	1,521	917	1,907	1,124	2,339
Flat Cast Iron: Contact Area 2⅝x7 in. less 2 openings for waste sponging $1^{15}/_{16}$x$^{15}/_{16}$=3¼ in., Area 15⅛ in.	380	790	609	1,266	834	1,735	981	2,040

Tests of Center Plates and Side Bearings, P., C., C. & St. L. Railway.

Anti-Friction Side Bearings.

The fourth and fifth subjects assigned to your committee relate to anti-friction side bearings, and are as follows:

The merits of anti-friction side bearings for relieving the center plate from part of the load.

Will the use of anti-friction side bearings diminish the resistance between the wheels and rails?

A circular was addressed to each member asking his co-operation to the extent of furnishing to the committee the result of such tests as had been made, and which was available. Of the members replying those giving opinions or furnishing data control about one-fifth of the car equipment represented in the association.

Twenty-three replies were received, the majority of which were favorable to the use of anti-friction side bearings.

Pittsburgh & Lake Erie R. R. Co.

This company has recently made some tests of ball-bearing center plates and side bearings, which may be of interest to your committee. The results obtained certainly prove the subject to be worthy of the most careful consideration.

On June 1, 1897, one 60,000-lb. capacity gondola car was equipped. The construction consisted of four steel balls 2¼ in. in diameter, between two malleable-iron center plates, the lower plate having four grooves equally spaced, 4 in. long, ¼ of an in. deep at the center, running out to nothing at the end. Lengthwise the grooves conformed to the radius of the bearing surface of the center plate. The upper plate had a groove ¼ in. deep, corresponding to the diameter of the balls and extending all the way around. The side bearings had each one steel ball of same diameter as those used in center plates; each bearing had a groove 15 in. long, same diameter as the ball, straight on the bottom, but curved to proper radius. Balls were protected by deep flanges on each bearing, the top passing down over the outside of the lower. The ends of the flange on upper bearing were cut so as to permit of the greatest curvature of truck.

After the car had been in service three years, proving clearly that the device was entirely practicable, a careful test was made to establish its value in the way of reducing flange and rail wear on sharp curves. A turntable 7 ft. long was made so as to determine, by the use of a dynamometer, the actual power required to displace a truck 2 in. at the end, or 4 in. in its length, equaling a 154 deg. curve. The appended report is the result of the trial:

Curve resistance on cars equipped with the Hartman ball-bearing center plate and side bearing, in comparison with the ordinary flat surface center plate and side bearing.

First Test.

Flat center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing:

		Resistance.
Required to start truck	800 lbs.	100%
Required to displace truck 2 in.	1,100 lbs.	100%

Second Test.

Flat center plate, without side bearing.

		Resistance.
Required to start truck	275 lbs.	34%
Required to displace truck 2 in.	525 lbs.	48%

Third Test.

Hartman ball-bearing center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing.

		Resistance.
Required to start truck	75 lbs.	9%
Required to displace truck 2 in.	450 lbs.	40%

Fourth Test.

Hartman ball-bearing center plate, without side bearing.

		Resistance.
Required to start truck	75 lbs.	9%
Required to displace truck 2 in.	325 lbs.	29%

This report, to our mind, clearly indicates two things, namely: We should have a frictionless side bearing to assist cars around curves with high outside elevation, but on straight and level track the load should be carried on the center plate, and by all means on a ball-bearing. The most valuable feature in the center plate in question is the dish in the grooves in the bottom plate, which answers two purposes, one being to keep the balls properly spaced and the other the tendency to straighten the truck quickly after leaving a curve, this being explained by the fact that the sluing of the truck on a curve forces the balls up the inclined plane of the grooves, and as soon as straight track is reached they naturally gravitate back to their proper position.

For your information we append a report of the service of the car in question:

Car built	April, 1896
Equipped with Hartman appliance	June, 1897
Miles run from June, 1897, to date	11,323
Approximated loaded mileage	7,548
Capacity of car	60,000
Tons carried one mile	226,440

Wheels show no flange wear up to date.

Wheels show no flange wear up to date.

The perfect condition of the wheel flanges demonstrates its value, not only as increasing the life of the wheel, but reducing train resistance.

L. H. TURNER, *Superintendent M. P.*

Duluth Iron Range R. R. Co.

SERVICE OF AUTOMATIC FRICTIONLESS SIDE BEARINGS.

EFFECT UPON FLANGE WEAR.

Year.	Wheels Removed. All Defects.	Removed for Sharp Flanges.	Per-centage.
1899	998	254	25.5
1900	2,248*	463‡	20.6
1901	1,815†	322	17.7
1902 (January & February).	372	24‡	
Approximate for year	6	6	
	2,232	144 approximate.	06.0‡

* An unusual condition affected this year's record. Over 60 per cent. of the removals, after deducting the wheels taken out for sharp flanges, were removed for flattened wheels in service.

†The automatic frictionless side bearings were in service all this year and affecting flange wear.

‡No removals for sharp flanges on cars with roller bearings.

Not considering the 200 cars built by the Illinois Car & Equipment Company, in 1899, there were 512 ore, flat, box and logging cars equipped with automatic frictionless side bearings in 1899 and 1900. Exact date of applications of the side bearings to 278 ore cars, 38 box cars and 70 flat cars (386 cars in all) in 1899 and 1900 are known, and also the dates of six applications to ore cars in 1901.

The wheel records show that for the year of 1900, after the automatic frictionless side bearings had been just applied, but had not been in service long enough to have appreciable effect upon the wheel flange wear, 463 wheels were removed from box, ore, flat and logging cars for sharp flanges. During 1901, when the bearings were in service on 512 old cars of these classes, and materially affecting the flange wear, only 322 wheels were removed

for worn flanges; a reduction of 30 per cent., notwithstanding that the wheels were an average of four years old when bearings were applied, that the car mileage had been increased, that train hauls had become greater, and that the equipment was one year older.

The indications are that the flange wear of 1902 shall be decreased in even greater proportion, as the effect of the side bearings on the service in general approaches its limit.

The service of 52 ore cars equipped with the roller bearings was compared to that of 52 cars with plain side bearings (the car numbers selected at random) for 1900. While no wheels whatever were removed from the 52 cars with the roller bearings, 17 wheels were taken from the cars with plain bearings for having the flanges worn. By comparing 300 ore and flat cars with the automatic frictionless side bearings with 300 cars with plain bearings for 1901, it was found that while 101 wheels were removed for sharp flanges from the cars having plain side bearings, only 16 wheels were removed for having the flanges worn, from those cars equipped with the automatic frictionless side bearings.

The question of the effect of the automatic frictionless side bearings on flange wear alone is presented, because the wear of the wheel flanges can be easily and definitely ascertained, but while the other economies and advantages are equally apparent, they can not be so accurately determined. It will be readily appreciated, however, that this reduction in flange wear shown means an equivalent reduction in rail wear, and a proportionate decrease in the draft of trains, and consequently a reduction in the cost of transportation. Again, the capacity and the life of the car bolsters are increased, and the cost of truck repairs considerably lessened.

H. S. BRYAN, *Master Mechanic.*

CONCLUSIONS.

Attention is called to the reduction in flange resistance by lubrication, the lubricant being a thick grease.

The replies received to the circular of inquiry from 18 members show a variation in distance, center to center, of side bearings and center plates, from 24 in. to 32½ in.

The height of center plates varies from 2½ in. to 7 in.

As to the (4) merits of anti-friction side bearings for relieving the center plate from part of the load, from the replies received from the members it would seem that opinion is about equally divided. Your committee is of the opinion, however, that with a center plate of proper design and material, and a truck and body bolster of sufficient strength, the load can and should be carried on but one bearing point, namely, the center plate.

As to the fifth subject, resistance between wheels and rails, it is the opinion of your committee, and this opinion is substantiated almost unanimously by the replies received from the members, that the use of anti-friction side bearings will diminish this resistance.

Attention is further called to the fact that when side bearings are in contact the pressure against wheel flanges is greater than with center plates alone in contact.

In this connection it might be well to state that your committee has received from one of the manufacturers of anti-friction side bearings an offer to furnish, free of charge, any number of its bearings that may be needed for the purpose of tests against plain bearings. This offer was received too late to be made available for the purposes of this report.

This report is signed by Messrs. B. Haskell (Chairman), H. M. Pflager, W. H. Marshall, T. W. Demarest.

OUTSIDE DIMENSIONS OF BOX CARS.

At the meeting of the American Railway Association, held April 24, 1901, the following principle regarding the construction of box cars was approved:

"That the essential elements of the standard box car require that the height and width be as great as are permitted by the physical limitations of the important railroad clearances and the present established height of loading platforms; that the length be determined by economy in construction, maintenance and operation and the requirements of economical storage."

At the convention of the same Association, held in St. Louis on October 23, 1901, in pursuance of the above principle, a Committee on Standard Dimensions of Box Cars submitted report in which the following resolution was offered for adoption:

"That the dimensions of the standard box car be 36 ft. in length, 8 ft. 6 in. in width, and 8 ft. in height, all inside dimensions. Cross section 68 sq. ft., capacity 2,448 cu. ft. The side door opening to be 6 ft. in width."

On a vote by the roads, the above resolution was adopted, there being but one dissenting vote.

The cross section and longitudinal measurements are the dimensions between lining, the vertical measurements being from top of floor to underside of carline.

The following resolution was adopted:

"That the Master Car Builders' Association be requested to consider and adopt the required external dimensions for the standard box car, based upon the interior dimensions as prescribed by the American Railway Association." . . .

Your committee carefully considered the physical limitations of clearances, etc., of the railroads of the country, bearing in mind the further limitations prescribed for inside dimensions by the American Railway Association and submitted to the members of this Association certain outside dimensions, as follows:

For a box car set on trucks used as standard, where the height from top of rail to top of floor is 4 ft.:

	Feet.	Inches.
Height, top of rail to upper edge of eaves..	12	6¾
Width at eaves, at above height, maximum	9	7⅜

For a box car set on low trucks, where the height from top of rail to top of floor is 3 ft. 6 in.:

	Feet.	Inches.
Height, top of rail to upper edge of eaves..	12	¾
Width at eaves, at above height, maximum	9	10

The members of the Association were asked to state whether or not they approved of the above dimensions; if not, wherein they should be modified to meet existing conditions. From the replies to this circular it was found that the exterior dimensions given above were satisfactory to a majority of the roads, but on certain of the trunk lines there were clearance limits which would not permit cars set on low trucks (3 ft. 6 in.) of the cross section given (9 ft. 10 in.) at the height of 12 ft. ¾ in., to pass.

To meet these conditions your committee has decided to modify its original recommendation in this respect, and would suggest 9 ft. 7 in. as the maximum width at eaves at a height of 12 ft. ¾ in., and for the sake of uniformity would also change its original recommendation as regards the width at eaves of cars set on trucks with 4 ft. in height to top of floor, from 9 ft. 7⅜ in. to 9 ft. 7 in., thus giving a standard width for cars of either height. . . .

The inside measurements having been established by the American Railway Association, and the outside dimensions being confined to the limiting clearances of the leading trunk lines, the committee has carefully considered the various forms of framing which have been submitted to it in order that the best possible construction may be had between these limitations, and it submits for your consideration what it believes to be a substantial box-car framing, which will carry the loads required and make a strong car in every particular.

Your committee would recommend that on all cars built to these dimensions the words and letters "Standard, 12 ft. 6¾ in. by 9 ft. 7 in." be stenciled in letters not less than 3 in. in height on the end fascia boards.

Your committee would also recommend that the dimensions for inside measurements of box cars as prescribed by the American Railway Association be adopted as the standard of this Association. . . .

Side Door.

The American Railway Association has recommended that the side door opening for the above car be 6 ft.

Your committee finds that there is much objection from the mechanical standpoint to the 6-ft. width of door opening for the following reasons:

1. It weakens the framing of the car both on the sill and plate lines.

2. The increased size in the width and height of the side door makes it extremely difficult to construct a door which will remain straight and prevent binding on the sides of the car, which has always been found to be very objectionable and destructive to both siding and door because of the indifferent manner in which our doors are manipulated at the freight houses.

3. On the grain carrying roads it would necessitate the use of a grain door so heavy and large that it would be impracticable for one man to handle it; additional complications would be entailed in its construction, and it would necessitate carrying in stock additional thickness of lumber in such size as not to be readily obtainable.

Your committee, while it has recommended for adoption as standard external dimensions which it believes adequate for strength for cars of the inside dimensions adopted by the American Railway Association, and has presented for your consideration certain details of car framing to meet these external dimensions, does not recommend these latter details for adoption. It believes that the time is now here for the adoption by this Association of a standard box-car framing, and it would recommend that a committee be appointed to propose for adoption as standard, at our next convention, a system of framing for box cars with inside and outside dimensions as above.

A brief summary of the recommendations herein mentioned is as follows:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 in. wide and 8 ft. high, be submitted to letter ballot for adoption as standard.

2. For box cars on high trucks (4 ft. to top of floor):

	Feet.	Inches.
Height, top of rail to upper edge of eaves..	12	6¾
Width at eaves, at above height, maximum	9	7

be sumbitted to letter ballot for adoption as standard.

3. For box cars on low trucks (3 ft. 6 in.):

	Feet.	Inches.
Height, top of rail to upper edge of eaves..	12	¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard 12 ft. 6¾ in. by 9 ft. 7 in." be stenciled in 3-in. letters on the end fascia boards on all cars built to these dimensions.

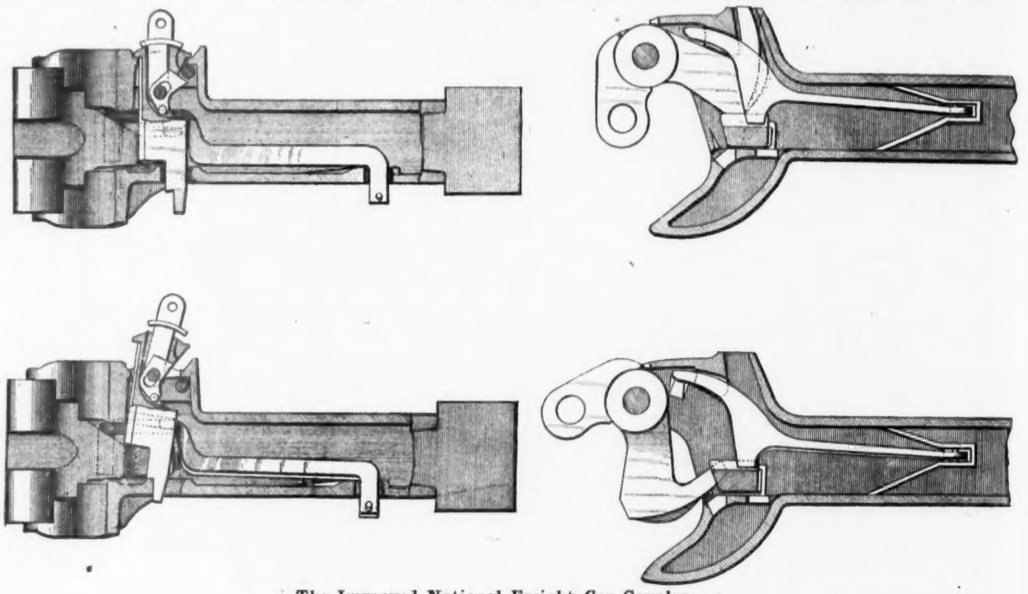
5. That a committee be appointed to report at the next convention a detailed form of framing for box cars, for adoption as standard.

This report is signed by Messrs. C. A. Schroyer (Chairman), G. W. Rhodes, W. P. Appleyard, Jos. Buker, J. N. Barr.

The Improved National Freight Coupler.

The improved coupler that is now being made by the National Car Coupler Co. is shown in the accompanying illustrations. The improvements are due to Mr. J. A. Hinson, President of the company, the features constituting these improvements being quite apparent from the engravings. They consist of a knuckle-opener and an auxiliary lock, or a lock for the lock.

The engravings show the lock in two positions; in the upper view it is closed, with the auxiliary lock in place; the lower is the uncoupling position. The knuckle lock has an opening in the top, having a depth equal to about half the length of the lock. A pin passes through the lock horizontally near the bottom of the opening, pivoting the movable head which fits in the hollow portion, and permitting a slight vertical motion of the head by means of slots in the walls of the opening. It will be seen that the auxiliary lock is also slotted and is pivoted in such a way that vertical motion of the movable head draws this lock back, permitting the coupler lock to be lifted. The lower view shows the small shoulder at the bottom of the lock resting on the rim of the opening through which it extends in the closed position. This feature permits the lock to be set preparatory to a separation of the cars without having to make use of the bracket at the corner of the car. The lock having been set in this manner, the cars can be uncoupled and coupled again without further attention from the brakeman.



The Improved National Freight Car Coupler.

The knuckle-opener, the form and position of which are shown very clearly by the figures, is a peculiar-shaped casting extending from the head back into the shank of the coupler, the rear end having a bend at right angles, which extends through an opening in the lower wall of the bar and has a pin inserted to prevent it from jumping or being forced out. An extension on the opener engages in a suitable slot in the lock. The vertical sections show the front of the opener to bend upward to the height of this lock-slot, extend horizontally and bend downward again as a leg. The front end of the opener is supported on a lug cast on the wall of the head; lifting the lock causes the leg to rotate, kicking the knuckle open. Ribs are cast on the inside of the bottom wall of the shank, which guide the rear end of the knuckle-opener to the opening through which it is designed to project. Should the drawbar be torn from its fastenings, and the lock chain break, this extension of the knuckle-opener will come in contact with the carrier-iron, preventing the bar from falling on the track, which is a desirable safety feature.

The coupler is made throughout of open-hearth steel, with a 1⅝-in. pivot pin. The knuckle-opener can be removed and the coupler used without it if desired. Other

auxiliary parts may likewise be removed, leaving a plain lock. The weight of the coupler complete is from 225 to 230 lbs.

The Edwards Extension Platform Trap Door.

The accompanying engraving shows the latest and most approved design of the Edwards extension platform trap door, for covering the steps of wide vestibule coaches. Reference to the *Railroad Gazette* of Sept. 7th, 1900, and June 14th, 1901, will give the reader the story of the evolution of this device. In the original design, as made by the O. M. Edwards Co., of Syracuse, N. Y., under the Seymour and Kahler patents, the trap-door which covers the coach steps had a torsion spring set in the hinge, which opens the trap when the latch is drawn back. This feature has been preserved in the later designs. The torsion spring (which consists of two flat steel bars) is fastened at one end in the hinge, and at the other end to a ratchet wheel placed in a bracket in the corner post of the car. By means of this ratchet wheel the torsion of the spring can be so regulated as to automatically place the trap door full open or in any intermediate position that may be desired.

The improvement which has lately been introduced consists of a modification of the arrangement which is used to open the trap door. Instead of disengaging, by hand, the detent which holds the door down, it is now done by the pressure of the foot. The mechanism consists of a foot lever pin, placed in the front end of the vestibule and protected by the usual signal step, which is fastened in the end of the vestibule. By pressing down on this pin, the lock bolt is withdrawn from the keeper in the door and this allows the door to swing up quickly out of the way.

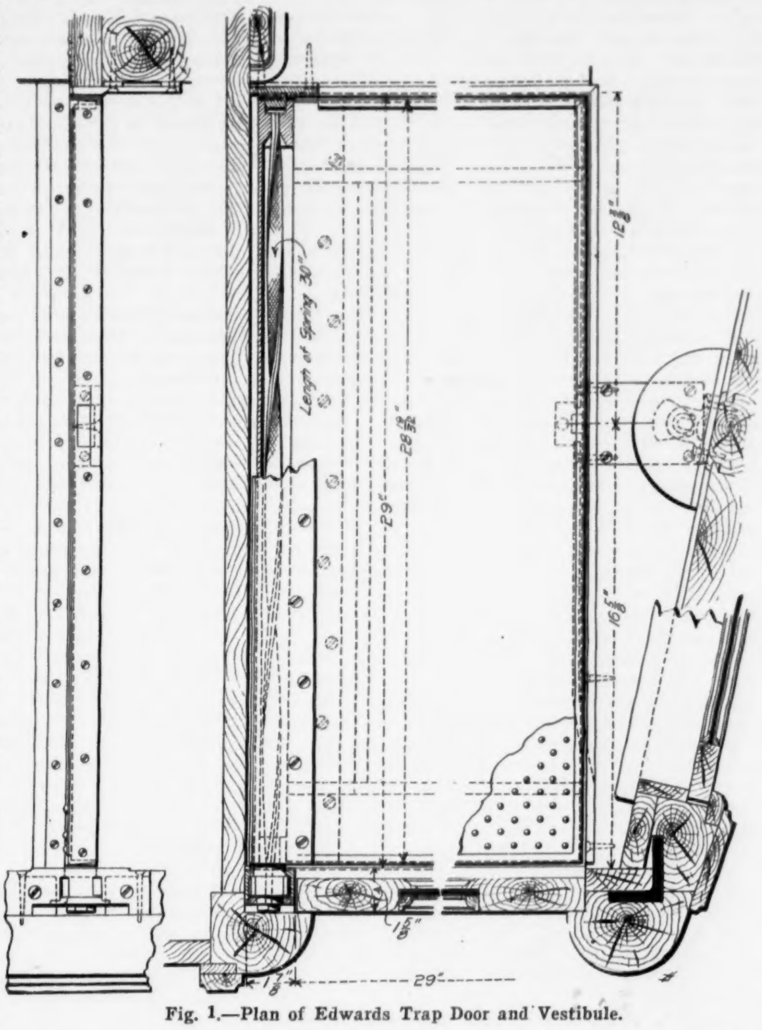


Fig. 1.—Plan of Edwards Trap Door and Vestibule.

The device is simple and positive in its action, but for still greater security an ingenious attachment has been added. As soon as the lock bolt is fully withdrawn, the lever, shown in Fig. 2, is brought up against the under side of the door. If the door should stick, this lever forces it up to a point where it cannot be bound by the platform. This arrangement while operating the door and dealing with contingencies, has another incidental advantage. The hand hold in the door, which has been found objectionable in practice, as a receptacle for water and dirt, has been discarded entirely.

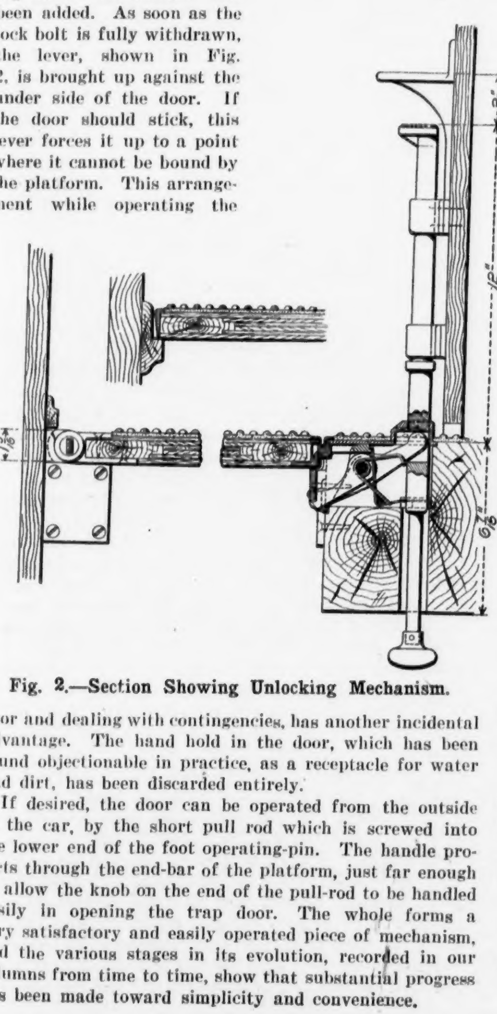


Fig. 2.—Section Showing Unlocking Mechanism.

If desired, the door can be operated from the outside of the car, by the short pull rod which is screwed into the lower end of the foot operating-pin. The handle projects through the end-bar of the platform, just far enough to allow the knob on the end of the pull-rod to be handled easily in opening the trap door. The whole forms a very satisfactory and easily operated piece of mechanism, and the various stages in its evolution, recorded in our columns from time to time, show that substantial progress has been made toward simplicity and convenience.

International Association for Testing Materials—American Section.

The fifth annual convention of this Association was held in Atlantic City, June 12, 13 and 14, with about 75 members and guests in attendance. It was the most largely attended and in every way the most profitable meeting that this organization has had.

The officers elected for the current year were: C. B. Dudley, Chairman; Robert W. Lesley, Vice-Chairman; Edgar Marburg, Secretary, and James Christie, Treasurer. The members of the executive board elected were: H. M. Howe, ex-officio, Albert Ladd Colby, James Christie and John McLeod.

After the election of the officers, the Association was reorganized as the American Society for Testing Materials, an incorporated society and independent of the International Association, except that the members of the new organization are all members of the International Association and new members in joining the one by doing so join the other. The officers that had just been elected were re-elected as officers of the new society, except that the offices of Secretary and Treasurer were consolidated. Mr. Christie resigned as Treasurer and Prof. Marburg became the Secretary and Treasurer.

The Society now numbers over 200 members, the larger proportion of whom are engineers and other scientific men not directly connected with the manufacture of metals.

The papers presented were exceptionally well prepared and the animated discussions showed the members to be interested in the topics presented. All of the papers presented will later be published in full, with the discussions, by the Society, in one volume. We print abstracts from several of these papers and expect, later, to present abstracts of all the papers that especially interest our readers. The list of papers read is as follows:

Is it desirable to specify a single grade of open hearth structural steel for bridges of ordinary spans? Messrs. A. P. Boller, Theodore Cooper, J. E. Greiner, C. C. Schneider, J. P. Snow and T. L. Condron.

The finishing temperature and structure of steel rails. Albert Sauvier.

Rail temperatures. S. S. Martin.

The relation between the basic open hearth process and the physical properties of steel. Dr. C. B. Dudley.

The Ethics of testing. Paul Krentzpointner.

The correlation of cement specifications. R. W. Lesley.

The advantages of uniformity in methods of testing and specifications for cement. G. S. Webster.

The chemical analysis of cement: Its possibilities and limitations. R. K. Mead.

Cement testing in municipal laboratories. R. L. Humphry.

Tests of reinforced concrete beams. Prof. W. K. Hatt.

Effect of variations in the constituents of cast iron. W. G. Scott.

The present status of testing cast iron. Dr. R. G. Moldenke.

The need of foundry experience for the proper inspection and testing of cast iron. Thomas D. West.

A quick foundry contraction test for metals. Asa W. Whitney.

High strength of white iron castings as influenced by heat treatment. A. E. Outerbridge.

One of the most interesting matters presented before the Society was on the subject of The Relation Between the Basic Open Hearth Process and the Physical Properties of Steel, by Dr. C. B. Dudley. Dr. Dudley's remarks were entirely informal and referred especially to the experience of the Pennsylvania Railroad Company with reference to steel axles. The first steel axles they used were purchased about 25 years ago and were made of basic open-hearth steel, having a tensile strength of between 62,000 and 68,000 lbs. per sq. in. There were 300 of these axles made by the Midvale Steel Co., and in the course of a few years a large number of them had broken in the journals. It, therefore, became evident that either larger axles or a different grade of material would have to be used, and it was finally decided to use axles having a tensile strength of approximately 80,000 lbs. Dr. Dudley now reports that they have used in service upwards of 380,000 axles made by the open-hearth process having a tensile strength of between 75,000 and 85,000 lbs. per sq. in. The larger percentage of these axles have been made by the basic process. Out of this very large number of axles they have to report but one axle failing by progressive fracture, and only three or four that have failed otherwise, due to pipes or other defects. The axle that failed by progressive fracture was, on investigation, found to have a tensile strength of but 68,000 lbs. per sq. in.

The experience Dr. Dudley related, with reference to axles, must surely have some bearing on the subject of what is a suitable grade of steel to use for railroad bridges, for while it is true bridge material is very differently handled in the shop, the evidence that the higher tensile steel axles are found to be so much better under the severe usage they receive in service leads to the conclusion that it is important for engineers and manufacturers to consider if steel above 60,000 lbs. tensile strength is not more suitable for railroad bridges in general than steel below 60,000 lbs.

One of the interesting papers presented was that on Tests of Reinforced Concrete Beams, by Prof. W. K. Hatt, of Purdue University. We hope to present Prof. Hatt's paper in a later issue.

TOPICAL DISCUSSION.—IS IT DESIRABLE TO SPECIFY A SINGLE GRADE OF OPEN-HEARTH STRUCTURAL STEEL FOR BRIDGES OF ORDINARY SPANS?

Alfred P. Boller (Consulting Engineer).—The special topic under discussion seems to embody the hopes of the mills, which can with advantage be nearly met for ordinary span bridges, and can be answered in the affirmative, excepting as to rivets and eye-bar material. There is no reason why plates and shapes should not be of a single grade open-hearth for such bridges, but eye-bar material, subject as it is to the subduing effects of forging and annealing, should be of a higher grade material. For large spans, which are rarely, if ever, committed to the care of other than bridge engineers, it is impracticable to set up any standard of uniformity and the character and adaptation of the steel must be entirely in the hands of such engineers. These cases involve so many special considerations that no rule can be laid down and any engineer qualified to design and administer the construction of such works is sufficiently well informed of mill possibilities as not to require impossible or impracticable results.

It may be of interest, in this connection, to note the table of steel requirements adopted by my firm, and on which some 30,000 tons of bridge material are now being gotten out for the Wabash entrance into Pittsburgh, for all types of construction; from the ordinary girder spans to the great cantilever constructions over the Monongahela and Ohio rivers, where the limits of pin-connected work are believed to have been reached. This table shows a practical uniformity in all material, other than in the rivet, eye-bar and pin requirements, and is believed to be as reasonable a demand on the mills as the present state of the art permits and yet permits of the engineer exercising such judgment in selecting his material as the nature of the work demands.

	Ultimate Strength per sq. inch. Min.	Max.	Elastic Ratio, Min. Per Cent.	Elong. in 8 in. Min. Per Cent.	Reduct of Area, Min. Per Cent.	Chemical Comp's'n Below P. Acid.	P. Basic.	S. Acid.	S. Basic.	Mn.
Rivet—	52,000	63,000	55	28	50	.04	.03	.05	.05	.60
Angles and Plates—	60,000	70,000	50	24	40	.06	.04	.05	.05	.60
Eye-Bars—	63,000	73,000	50	24	40	.06	.03	.04	.04	.60
Cast Steel—	65,000	75,000	50	20	30	.08	.04	.05	.05	.80
Pins—	65,000	75,000	50	In 2 inches. 22	33	.06	.04	.05	.05	.60

Theodore Cooper (Consulting Engineer).—The evolution of the use of steel for structural purposes in this country may be said to have started about 1870, when Mr. Wm. Butcher convinced Capt. James B. Eads that he could furnish him steel of 100,000 lbs. tensile strength able to stand without permanent set 60,000 lbs. compression and 40,000 lbs. tension.

The metallurgical, mechanical and financial struggles of this experiment, while full of interest and instruction, were sufficient to discourage for some years further efforts in this line.

The next step, of which the writer had personal ex-

perience, was the "Hay" steel experiment of the Glasgow Bridge in 1878. This bridge was finally built of acid Bessemer steel.

About 1887 basic soft steel could be obtained on more favorable terms than iron of the same sections. From that time until now we have recognized two standard grades of structural steel, when, as was then true, they were really two different metals, viz., basic soft steel and acid Bessemer medium steel, and especially during the gradual disappearance of the metal iron and recognition of the new metal, the two grades were proper and necessary. Now practically these two grades are merely overlapping ranges of the same material. Under the manufacturers' specifications steel from 60,000 to 62,000 lbs. is both "soft" and "medium," and it is natural that where the orders for the two classes are equally probable, the objective point will be for material to suit either order.

Believing that both the interests of the steel manufacturers and of the steel users will be advanced by the adoption of *one common standard*, I think the time has come to advocate the same. But do not understand me to mean that we have yet got a material with which either the maker or user should or can be satisfied. But we can, perhaps, determine a common objective point or average material for a standard and the struggle of the immediate future, instead of being devoted to getting miscellaneous varieties of steel to suit individual tastes or vagaries, should be to improve and perfect that one standard. With one average material in view the steel manufacturer should be able to systemize his output to give far greater uniformity than he has heretofore. The users of steel under *one standard material* should demand an important reduction in the limits of variation from the standard average. Under the present limits demanded by the manufacturers of steel there is a difference of 10,000 lbs. between the *minimum*, which determines the strength of our ships, bridges and other structures, and the *maximum*, which measures the workability of the material.

In spite of the manufacturers' limit of 10,000 lbs., there has been no difficulty for years in getting this limit reduced to 8.000 lbs. Is it chimerical, then, to believe that with one class of material in view we can get this reduced to 6,000 lbs.? If this result can be had, as I believe, why should we bend, form, work and punch steel of 70,000 lbs. to get a ship or bridge rated at 60,000 lbs. The difference in workability of 4,000 lbs. is worth money and the manufacturer who can give the most uniform material should be favored even at an advanced price.

In advocating one standard structural material I have in view all structures and not simply bridges. There is no just reason why the material for ships, bridges or buildings should be different, and there will be no gain in the character of our material unless we can harmonize the requirements to suit all.

What is the average material which would meet the views and needs of shipbuilders, manufacturers of structural work, steel makers and engineers, under the expectation of the future material being more uniform than we are now offered? I suppose it will lie somewhere between 60,000 and 66,000 lbs., many, perhaps, considering one too low and the other too high.

Personally I should consider under the above claims an average of 65,000 lbs. steel or steel varying between the limits of 62,000 and 68,000 lbs., as the ideal material we should expect. The ductility and other qualities being at least equal to those now required of medium steel.

J. E. Greiner (Bridge Engineer, B. & O. R. R.).—There were a number of conservative engineers who made a strong fight for the retention of wrought iron for structural purposes and who kept up their struggle so long as iron could be obtained. Some of these engineers had a very unsatisfactory experience with steel structures and naturally preferred to adhere to a metal whose quality had been determined by long and continued use.

Later those who entered the field of steel made a sufficient number of tests to satisfy them that open-hearth steel varying from 52,000 to 65,000 lbs. could stand more abuse than the best double rolled iron. It could be punched and sheared when thickness did not exceed ⅝-in. with no greater injury. When the ultimate strength ran over about 68,000 lbs. punching and shearing had a tendency to injure the metal, but it was found that this damage could be removed by reaming and planing.

These conditions then naturally suggested two grades of steel, namely, a soft steel to be worked the same as wrought iron and a medium steel in which all holes are to be reamed or drilled and all sheared edges planed off.

It has been the general practice for the past six or eight years for bridge engineers to specify these two grades, the soft being used as a substitute for wrought iron, and medium for eye-bars, or members which were to have holes reamed or drilled and edges planed, and to be used in structures of such magnitude that the saving in weight justified the more expensive shop work.

All things considered, an open-hearth steel ranging from 55,000 to 65,000 lbs. is about as satisfactory as can be obtained for structural purposes. It will meet all of the requirements for soft steel and will be worked under the same conditions as wrought iron; will be just as safe, and unit stresses may be taken 20 per cent. greater. This has been the writer's practice for the past two years and is embodied in the B. & O. Railroad specifications for 1901.

A single grade as above outlined will sooner or later become standard. If not recommended by some technical association of high standing it is quite possible that the manufacturers will realize the advantage of such a single grade, not only to themselves, but to the users as well, and then we will be offered the choice of either accepting the standard product of their mills or paying a fancy price to gratify our own desires.

The adoption of a single grade of structural steel would not affect the present soft steel output for rivets. We are not yet ready to use anything but a very soft steel for rivets, especially when driven by hand. When all rivetting is done by power there can be no objection to using the single grade steel as above outlined, even for rivets.

C. C. Schneider (Vice-President, Am. Bridge Co.).—The writer desires to depart from the strict wording of the question, and discuss the desirability of using one grade of steel for all ordinary structures, including material for shipbuilding. If there is any advantage to the manufacturer in using a single grade of steel for railroad bridges the advantage would be so much greater if the manufacturer of structural material could confine himself to that one grade entirely, excepting when special steel is required for structures of unusual magnitude, which occurs only once in several years.

The *extensive* use of steel as a structural material did not commence until the year 1890. Before that time steel was used only in isolated cases or for heavier work, such as chords and eye-bars for larger bridges. About 1890 some railroads commenced to build even smaller spans and plate girders of steel and for eye-bars steel was almost exclusively used. At about that time most of the structural mills that had formerly manufactured wrought iron had equipped themselves with steel furnaces, but continued for some time to make both kinds of material, until they found it more profitable to confine themselves to the manufacture of structural steel only and discontinued the manufacture of wrought iron. In 1894 it was practically impossible to obtain wrought iron shapes and those engineers who would have preferred wrought iron were obliged to use steel instead, and naturally specified a grade of steel as near wrought iron as possible, using also the same unit strains and workmanship as for wrought iron.

This accounts for the two grades of steel being at present in use, medium steel by the advocates of steel, soft steel by the advocates of wrought iron. As steel has now been extensively in use for structural work for a long time—medium steel for at least 20 years and soft steel for at least 10 years—we certainly have passed the experimental stage and should be in a position to decide for *one* grade of steel for ordinary structural work. This will be of advantage to the producer and consumer. The manufacturer of steel will be able to conduct his business in a more systematic and rational manner than he can do at the present time. If he uses the same quality of stock he will be able to use the same mixture and obtain uniform results satisfactory to the specifications. The manufacturer of bridges and structural work will be able to keep the usual sizes of shapes and plates in stock.

There is still another reason why this Association should take a decided stand in favor of one grade of steel and that is, that all other countries which have adopted standard specifications use only one grade of steel for structural work. Now admitting that it is desirable to use one grade of steel only, the question arises, what is the proper grade of steel for structural work? In deciding this question we should consider the process of manufacture in its present state and the probabilities of the future. At present most of the structural steel is made by the basic process and appearances indicate that the basic process will also be the process of the future for ordinary structural steel. It would therefore seem expedient to adopt a grade best suited to the basic process. For special higher grades of steel the acid process will probably hold its own.

The most satisfactory material which can be produced by the basic process averages about 58,000 to 60,000 lbs.; the writer would therefore recommend an ultimate strength of 60,000 lbs. per square inch, varying 5,000 lbs. either way. This grade of steel, in the writer's opinion, may be used without planing or reaming up to a thickness of about ⅝-in., without impairing its strength. Table No. II., appended hereto, gives the grades of steel used for bridges and structural work in some of the countries which have adopted standard specifications.

Table No. II.—Specifications for Bridges and Buildings.

Name of the authority or society.	Kind of material	Tenacity Tests. Tenacity lbs. per sq. inch.	Elong. in 8 in., P.C.
French Ministry of Public Works, Aug., 1891	Plates and bars at least	60,000	22
	Rivets	54,000	28
Austrian Ministry of Commerce, 1892	Plates and bars, l'gthwise	50-64,000	28-22
	Tranverse	50-64,000	26-20
	Rivets	50-57,000	32-26
Standard Specification of German Societies, 1892	Bars and plates of ¼ to 1⅛ in. thickness, l'g'hwise	53-63,000	20
	Transverse	51-64,000	17
	Rivets and screws	51-60,000	22
Federal Council of Switzerland, 1892	Bars and short plates	51-64,000	25-20
	Long plates, lengthwise	51-64,000	25-20
	Long plates, transverse	51-64,000	22-18
	Rivets and screws	51-60,000	28-24

J. P. Snow (Bridge Engineer, B. & M. R. R.).—I favor a single grade of steel for structural purposes for these reasons, first, because there is really no defensible argument why all ordinary bridges should not be made of the same class of metal. These bridges are essentially alike in the service to which they are subjected and what is best for one must be best for all. Second, if one grade is used by all builders, the melters and other workmen at the mills will become expert in the manufacture of this grade and the product will be more uniform and all the melts will hit the average of the range much more closely than is now the case, when the workmen are called upon to produce material all the way from extra soft to quite hard. Third, if a uniform grade is specified by all buyers of bridges the shops will not experience the trouble that they now do from the impossibility of using stock bought for other bridges to fill up gaps in a job on which they are at work.

I would not, however, agree to a single grade unless it covers soft steel. I prefer a steel averaging 57,000 lbs. ultimate strength per sq. in., with a range of 4,000 lbs. each way, but will join in approving an average, if not exceeding 60,000 lbs., with a range not exceeding 5,000 lbs. each way.

I am aware that many prefer what is called medium steel ranging up to 70,000 lbs. ultimate. My objection to this is, first, that although the punched holes are reamed and the sheared edges planed, the whole of the danger from rough treatment may not be removed. The damage done to steel by the punch and shear lies in compressing it locally far beyond its limit of recovery, thereby rendering it unfit to resist tension. We demonstrate this when we bend a wire back and forth until it becomes so brittle that it breaks short off. The gag of the straightening press, cold rolling and severe local hammering produce practically the same effect as the punch and shear, but reaming and planing do not remove these latter injuries.

Secondly, reamed medium steel with higher units and correspondingly lighter sections does not make so rigid a bridge as soft steel with low units and heavier sections, although its ultimate strength may be as great or even greater. The true value of a bridge consists in its stiffness and rigidity, coupled with strains below the elastic limit. If light and subject to much motion under service a bridge is condemned if the unit strains reach a certain maximum without considering whether the steel is soft or medium or whether the holes are punched, reamed or drilled. These among other reasons lead me to prefer soft steel which is not seriously injured by reasonable treatment if the metal is not too thick.

T. L. Condron (Consulting Engineer).—At the third annual convention of the American Railway Engineering and Maintenance of Way Association the subject of specifications for rolled steel was presented in the form of a report of the committee on iron and steel structures. That committee gathered statistics upon the subject of specifications in use. The replies received from 40 correspondents showed the following opinions or preferences:

In favor of two grades of steel, "soft and medium:" 14 railroads, 7 manufacturers of steel, 9 consulting engineers and 7 scientific schools.

In favor of one grade of steel: three railroad engineers—one, 55,000 to 65,000 lbs. steel; one, 57,000 to 66,000 lbs. steel, and one, 58,000 to 68,000 lbs. steel.

Notwithstanding the apparent general opinion in favor of two grades of steel, it was known to the committee that a large number of engineers limited themselves to one grade of steel in their bridge specifications. It was therefore proposed to the general committee by the subcommittee having the matter directly in hand that a recommendation be made by the entire committee of one grade of steel for bridge building, to be known as "structural steel," having a range of ultimate tensile strength of 55,000 to 65,000 lbs. per sq. in. This proposition was not favorably received by all of the committee, and the objections to such a recommendation were briefly these, as stated in the convention:

"The users of medium steel do not see why they should rule out what they believe to be a very excellent grade of steel between 65,000 and 70,000 lbs., if it is to be reamed, and place the upper limit at 65,000 lbs. It has been stated that the same class of service is required of practically all our bridges that are built, which is true; but the structures are built in two radically different ways by different railroad companies. A large percentage of the railroads entering Chicago and our Western roads are having their bridge material reamed; the reamed tonnage is constantly increasing and is a considerable proportion of the tonnage for our Western roads. On the other hand, some roads have not come to this reaming so generally. Of the two classes of structures, one is the class where the material is punched and not reamed, and the other the class where the material is punched and reamed, and the advocates of the two classes of steel are those who believe in reaming and believe they can use a higher unit of strength where the material is reamed. They do not see why they should limit their working stresses to such a low point as is only permissible for work that is simply punched. That is the gist of the whole argument and the reason why some of this committee have declined to agree on a 55,000 to 65,000 lb. steel."

On June 10 this subject was again discussed at a meeting in Chicago by the following bridge engineers: Mr. Parkhurst (Ill. Central), Mr. Loweth (C., M. & St. P.), Mr. Finley (C. & N. W.), Mr. Dawley (C. & E. I.), Mr. Cartlidge (C., B. & Q.), Mr. Ziesing (Am. Bridge Co.), Mr. Allen (Wis. Bridge Co.), and Messrs. Modjeski, Schaub, Strobel and the writer, consulting engineers. The general opinion expressed was that one grade of steel would be more desirable for structural purposes than two, both for the manufacturer and user, but that 55,000 lbs. is unnecessarily low for the lower

limit. While all of these engineers are in favor of reaming of main sections, they realize that some roads are not doing so at this time and will therefore wish to use softer steel than would satisfy those who ream. On the other hand, the steel used for buildings is nearly always the so-called medium steel, 60,000 to 70,000 lbs., which is not reamed. It is therefore likely that objection would be raised to reducing the strength of building steel below the present 60,000 lbs. minimum. If the engineer could be satisfied that the tests reported to him, fully, as well as fairly, represented the physical properties of the steel he is using, he would have no objection to an extreme range of 10,000 lbs. in ultimate tensile strength; but he realizes this is not the case and with only the few tests (frequently but one for a heat of 30 to 40 tons), he must allow for a variation of four or five thousand pounds below or above the result of the tests reported. For this reason he thinks he should restrict the range of tensile strength to 8,000 lbs., instead of 10,000 lbs. In the Chicago meeting above referred to the general opinion was that a single grade of steel having a range of tensile strength, as shown by the ordinary tests, from 58,000 to 66,000, or 57,000 to 65,000 lbs. as a second choice, would come the nearest to suiting all interests, so far as railroad work is concerned.

Regarding ranges of physical properties in any one melt of steel and the likelihood that steel varying 4,000, 6,000, or even 8,000 lbs. above or below what any one test shows, attention is called to the results shown below in Tables A, B and C.

Table A shows the maximum and minimum results and the differences between these results from tests of plates of the same thickness and from the same heat. These tests were made on a lot of 200 tons of basic open-hearth plates, rolled from 13 different heats into five different gages. It will be seen from Table B, which is condensed from Table A, that in the case of the ultimate strength the variations in one gage and one heat were from 2,500 to 8,800 lbs., or, including the exceptionally wild heat, "J," 12,300 lbs. per sq. in. Similarly the yield point varied 1,700 to 12,600 lbs. per sq. in. and the elongation varied from 3 to 12 per cent.

In Table C, results of tests from another lot of plates are shown. In this lot the variations of ultimate strength in the same gage and heat were from 1,300 to 8,500 lbs., and in yield point 1,500 to 12,200 lbs., and in elongation from 1 to 6 per cent.

TABLE A.

Gage.	Heat.	No. of tests.		Tensile strength.	Max. dif.	Yield point.	Max. dif.	Elong. 8 in., P. C.	Max. dif., Per cent.
			Max.	54,900		31,600		32.0	
⅝ in.	K	5	Min.	51,400	2,500	29,900	1,700	26.0	6.*
			Max.	57,500		34,900		29.0	
	L	6	Min.	50,700	6,800*	29,300	5,600*	26.0	3.
			Max.	58,300		33,700		30.0	
	M	5	Min.	55,900	2,400	31,600	2,100	27.0	3.
			Max.	60,200		35,100		29.0	
	N	4	Min.	55,600	4,600	30,800	4,300	26.0	3.
			Max.	59,400		33,400		31.0	
½ in.	A	7	Min.	55,800	3,600	30,200	3,200*	27.0	4.*
			Max.	58,200		34,100		30.0	
	B	11	Min.	51,700	6,500*	31,400	2,700	27.0	3.
			Max.	56,200		33,000		33.0	
7/16 in.									
	C	4	Min.	53,400	2,800	31,300	1,900	31.0	2.
			Max.	59,000		33,500		32.0	
	B	13	Min.	52,200	6,800*	29,700	3,800*	27.0	5.*
								Elong. in 5 in.	
			Max.	60,200		35,900		40.0	
5/16 in.									
	D	12	Min.	51,900	8,300*	29,900	6,000*	29.0	11.*
			Max.	61,300		35,300		38.0	
	C	7	Min.	57,700	3,600	31,800	3,500	30.0	8.
								Elong. in 4 in.	
			Max.	58,400		33,300		38.0	
¼ in.	E	4	Min.	52,800	5,600	29,300	4,000	35.0	3.
			Max.	60,800		41,800		43.0	
	F	37	Min.	52,000	8,800*	29,200	12,600*	33.0	10.
			Max.	60,700		39,000		43.0	
	G	32	Min.	52,100	8,600	29,000	10,000	35.0	8.
			Max.	61,200		41,900		37.0	
	H	8	Min.	53,400	7,800	31,000	10,900	25.0	12.*
			Max.	76,000		36,900		38.0	
	J	8	Min.	63,700	12,300**	33,300	3,600**	33.0	5.**

* Maximum for each gage.
** Maximum for ¼ in. gage testing above 62,000 pounds.

TABLE B (Variations found in the same heat and gage).

Thickness.	Heat.	Tensile strength.	Heat.	Elastic limit.	Heat.	Elongation. P. C.
⅝ in. . .	L	6,800 lbs.	L	5,600 lbs.	K	6.0
½ in. . .	B	6,500 lbs.	A	3,200 lbs.	A	4.0
7/16 in.	B	6,800 lbs.	B	3,800 lbs.	B	5.0
5/16 in.	D	8,300 lbs.	D	6,000 lbs.	D	1.1
*¼ in. .	F	8,800 lbs.	F	12,600 lbs.	H	12.0
**¼ in. .	J	12,300 lbs.	J	3,600 lbs.	J	5.0

* Tensile strength under 62,000 lbs.
** Tensile strength over 62,000 lbs.

TABLE C (Variations found in the same heat and gage).

Gage.	Heat.	No. of tests.		Tensile strength.	Max. dif.	Yield point.	Max. dif.	Elong. 8 in., P. C.	Max. dif. Per cent.
			Max.	58,500		39,900		30.5	
19/32	O	14	Min.	54,900	3,600	37,400	2,500	27.0	3.5
			Max.	57,000		39,500		29.5	
17/32	O	4	Min.	54,000	3,000	37,600	1,900	28.0	1.5
			Max.	58,300		42,000		30.5	
½	O	4	Min.	54,400	3,900	38,200	3,800	25.0	5.5
			Max.	59,800		43,800		28.0	
½	P	10	Min.	56,700	3,100	40,900	2,900	23.0	5.0
			Max.	63,800		42,700		30.0	
15/32	P	22	Min.	55,900	7,900	30.500	12,200	24.0	6.0
			Max.	61,600		42,100		30.0	
13/32	Q	6	Min.	55,800	5,800	38,600	3,500	26.0	4.0
			Max.	66,700		44,300		27.5	
⅜	R	12	Min.	58,200	8,500	40,700	3,600	22.5	5.0
			Max.	61,000		41,300		26.0	
5/16	S	4	Min.	59,700	1,300	39,800	1,500	25.0	1.0

These are not exceptional results, but are what is constantly observed, and if variations of 6,000 and 8,000 lbs. in ultimate strength are found in the same gage and heat it must be conceded that as great or greater variations are to be found in different gages of the same heat. Therefore, if only one test or even two tests per heat are required it is important that such tests fall within narrow limits. If more tests are to be made then it would be rational to expand the limits allowable for such tests.

In conclusion, the writer believes that the time has come for recommending a single uniform specification for structural steel for ordinary uses (not including rivets or pins), and since our American manufacturers have demonstrated that they can make a steel of an average tensile strength of about 62,000 lbs., he would favor 62,000 lbs. as a basis, making the range 4,000 lbs. above or below 62,000 lbs. The recommendation of the committee of the Maintenance of Way Association has been for a range of 8,000 lbs., in which tests would be accepted, allowing the making of retests where the first tests are not more than 1,000 lbs., outside of the 8,000 lbs. range. In the writer's opinion, this 1,000 lbs. should be made 2,000 lbs. The writer suggests the following range:

56,000 to 58,000 lbs. tensile strength. . . .2 retests required
58,000 to 66,000 lbs. tensile strength. . . . . . . .Tests accepted
66,000 to 68,000 lbs. tensile strength. . . . .2 retests required
Below 56,000 lbs. or above 68,000 lbs. tensile strength. . Rejected

Of course, the other properties would have to be fixed upon in harmony with this range and rivet and pin steel are not included, as the former should be peculiarly soft and ductile, ranging between 50,000 and 58,000 lbs. tensile strength, and the latter may best be quite hard, like axle steel, ranging between 75,000 and 85,000 lbs. tensile strength.

The McKeen Tandem Spring Draft Gears.

In addition to the McKeen Friction Draft Gear illustrated and briefly described in our last week's issue, the Keystone Railway Supply Co., Easton, Pa., is putting on the market two types of tandem spring gears, a box follower and a push bar gear. The box follower tandem gear shown in Fig. 1 has only two pieces to be carried in stock for replacement, the box followers and cheek plates both being interchangeable. When the box moves 1⅞ in. in either direction the stress is transmitted to the center stop, thus distributing it through the cheek plates to the end stops. The projections on the ends of the box enter corresponding holes in the other box engaging the springs and although only one box is in motion both springs are compressed at the same time. The center stop with the side stop on the boxes limit the motion to 1⅞ in., thus preventing the setting up of the springs and limiting the load brought to bear on the projections to the spring pressure. The parts as shown in Fig. 1 are 1, yoke; 2, box followers; 3, draft springs; 4, cheek castings.

Fig. 2 shows a form known as the Push Bar Tandem, which has been devised to meet a demand for a cheap tandem attachment. The special castings are only two in number, namely, the push bar and the cheek plates. Four wrought-iron followers are required. The push bar is made of steel and has cast upon it projections which engage the circular followers, giving a movement of the springs identical in principle with that of the box followers. Numbers on Fig. 2 refer to the parts as follows: 1, yoke; 2, follower plates; 3, draft springs; 4, cheek plates; 5, push bars.

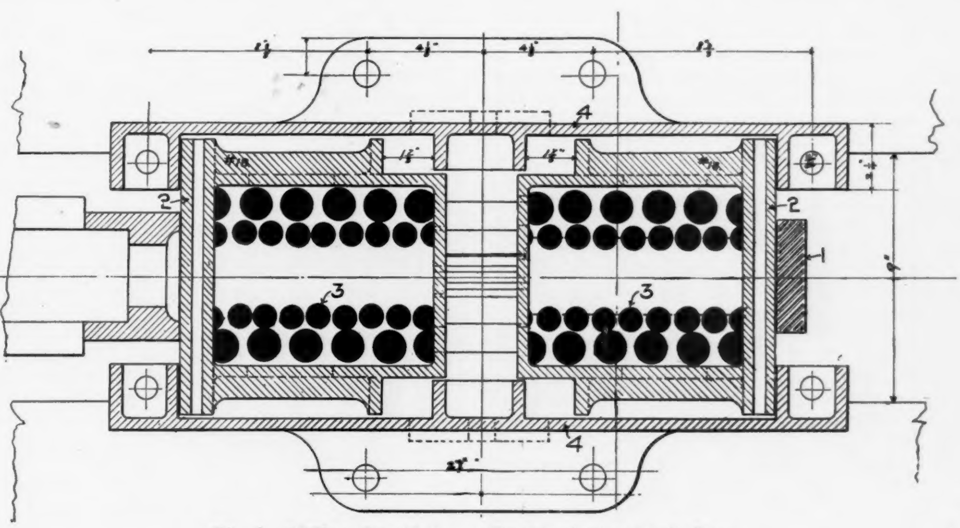


Fig. 1.—McKeen Box Follower Tandem Spring Draft Gear.

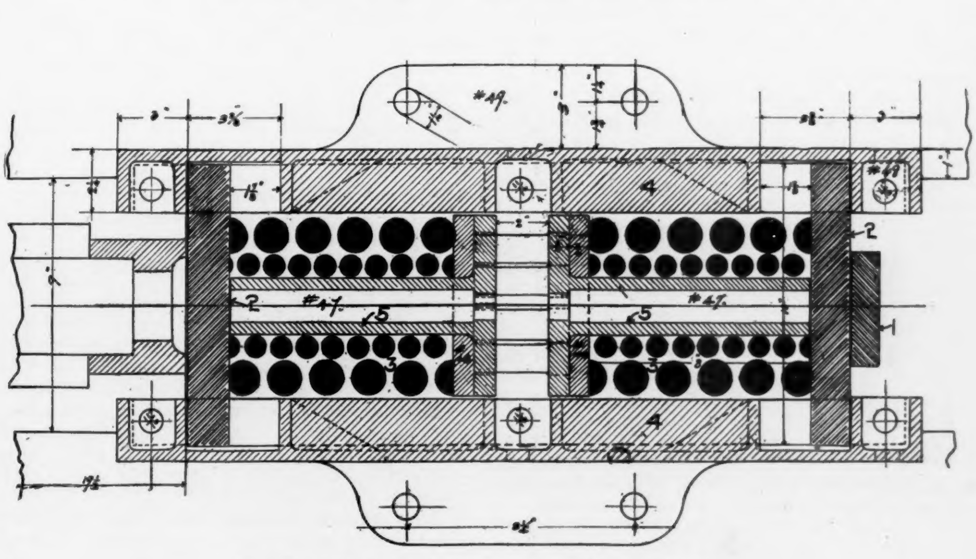


Fig. 2.—McKeen Push-Bar Tandem Spring Draft Gear.

The United States Shipbuilding Company.

The United States Shipbuilding Company has been organized under the laws of New Jersey to acquire the plants and equipment of the following concerns: The Union Iron Works, San Francisco, Cal.; the Bath Iron Works, Limited, Bath, Me.; the Hyde Windlass Company, Bath, Me.; the Crescent Ship Yard, Elizabethport, N. J.; the Samuel L. Moore & Sons Company, Elizabethport, N. J.; the Eastern Shipbuilding Company, New London, Conn.; the Harlan & Hollingsworth Company, Wilmington, Del.; the Canda Manufacturing Company, Carteret, N. J.; the Bethlehem Steel Company, South Bethlehem, Pa. The capital stock consists of $10,000,000 6 per cent. non-cumulative preferred stock and $10,000,000 common stock. First mortgage 5 per cent. 30-year gold bonds to the amount of $9,000,000 are offered to the public by the Trust Company of the Republic at 97½. This is part of an authorized issue of $16,000,000. The directors are: Henry T. Scott, President, the Union Iron Works; John S. Hyde, President, the Hyde Windlass Company; Charles R. Hanscom, President, the Eastern Shipbuilding Company; Charles J. Canda, President, the Canda Manufacturing Company; Daniel Le Roy Dresser, President, Trust Company of the Republic; Lewis Nixon, the Crescent Ship Yard; E. W. Hyde, President, the Bath Iron Works, Limited; Irving M. Scott, Vice-President and General Manager, the Union Iron Works; Horace W. Gause, President, the Harlan & Hollingsworth Company; John J. McCook, of Alexander & Green.

Speaking of the acquisition of the Bethlehem Steel Co., which was accomplished on June 15, some time after all

arrangements for control of the other plants were finished, Lewis Nixon said:

The acquisition of the Bethlehem Steel Company by the United States Shipbuilding Company is the most important industrial step taken in this country since the formation of the United States Steel Corporation. It gives to the United States a company capable of building a battleship complete with armament, armor and all equipment. No such company exists elsewhere in the world. Arrangements have been made with the United States Steel Corporation by which prompt deliveries of hull steel on favorable terms will enable us to promise vessels absolutely on time. More important, however, is the fact that, in case of bidding for vessels in competition with European builders, our hull steel will be obtained at a price that will not cause us to lose contracts on account of the price of steel. The Bethlehem Steel Company is now making armor and forgings and building guns and gun carriages for the United States, Europe and Mexico, and work is in sight that will tax the capacities of Bethlehem and the shipyards far beyond that made by their present volume or orders. This company can now enter with confidence the foreign field and demand and obtain its share of the world's shipbuilding, despite the adverse conditions which have heretofore confronted the American shipbuilder. The shipyards not in our consolidation will reap the benefits due to the healthy competition, as our desire is to put ourselves in shape to compete for foreign work, and in doing this we shall be doing the greatest possible service to the American ship owner and doing our part in bringing back the American flag in the foreign trade. We can develop shipbuilding mechanics that will, in time, undoubtedly repeat the lessons of other industries' having a steady demand for their products, and so give stability in employment and greater earning power to the workers. Whatever brings about a healthy and enduring shipbuilding industry here will benefit every calling, profession and trade, and every American should be proud to see the establishment of a company upon a financial scale and technical basis that insure success.

The formation of this company at so nearly the same time as the so-called Morgan consolidation of Atlantic lines is interesting. It will be remembered that in the agreement with Messrs. Harlan & Wolff it was distinctly specified that new ships might at any time be built in the United States, and it is probably safe to say that the formation of the United States Shipbuilding Co. greatly increases the chance that some share of this work will find it way to the United States.

Early History of the Delaware, Lackawanna & Western Railroad and Its Locomotives.*

BY HERBERT T. WALKER.

PART IV.—EXTENSION OF THE MORRIS & ESSEX RAILROAD.

On August 1, 1848, the road was completed to Dover and in the same year an engine named "Morris," built by Rogers, was put in service. This year also marks the final disappearance of the old strap rails, rails of T section having by that time been adopted. Mr. David M. Harris has given the writer a sketch of this rail, showing there was a cast-iron chair on every tie, the rail fitting snugly into the jaws of the chair. There was a key-way the whole length of the rail, and a key-way on the inside of the chair, the key serving to prevent the rail lifting out of the chair.

The first engine fitted with link motion for this railroad was the "Warren," also built by Rogers, in 1850. In the following year a 10-wheel freight engine named "Essex," by the same builder, was received.

The first hard-coal burning locomotive came from Danforth, Cooke & Co., about 1854, and was named "Pohatcong." No drawings of these engines have survived, but they were of practically the same design as contemporary engines by the same builders that were in service on the D., L. & W. R. R., and they will be fully illustrated and described in their proper place.

There were also three engines purchased in the early fifties. They were named "Hudson" and "Pequest," built by Danforth, Cooke & Co., and the "Passaic," built by Swinburne, of Paterson, N. J. This last engine had a suspended link motion and inside valve chests.

By an act approved March 10, 1853, the M. & E. R. R. Co. and the N. J. R. R. & T. Co. were authorized to make such arrangements as to allow business operations to be carried on with the continuous use of steam power and a 10 years' contract, dated Oct. 13, was accordingly made, the M. & E. R. R. Co. paying the latter road $25,000 a year for hauling their trains to Jersey City, thus doing away with the miserable horse-car service. At this time the cars were hauled via Centre street, instead of Market street; it appears, however, that the Newark Common Council agreed to allow the M. & E. R. R. trains to cross Broad street with the understanding that the tracks on Broad and Centre streets would be removed. In the beginning of August, 1854, the M. & E. trains commenced running across Broad street and the new bridge, built for the purpose by the N. J. R. R. & T. Co., but, as freight trains continued to be run on Broad and Centre streets, the city authorities, by order of the Common Council, tore up about 400 feet of the tracks on Nov. 4, 1854. The next day the railroad company attempted to relay the tracks and during the turmoil a false alarm of fire was given and the fire companies turned out, adding much to the confusion and uproar, during which some of the railroad officers were arrested. Ultimately the railroad company procured an injunction against the city and relaid the tracks, and business was resumed as before.

At this period B. Vanderpoel was president, and the road was under the charge of Superintendent Van Renselaer, J. B. Bassinger being chief engineer, with headquarters at Dover.

On Jan. 16, 1854, the road was opened as far as Hackettstown, and the traffic by this time was slowly increasing. From a time-table dated May, 1854, we learn that the distance between Hackettstown and Orange was covered in 2½ hours, which would make the average speed about 18 miles an hour, including 8 stops.

On Dec. 11 of this year the short line called the Sussex Railroad was opened for business. As far back as 1836 a preliminary meeting was held at Newton, N. J., for organizing the railroad, but nothing was done until 1853, and the company was chartered Feb. 5 of that year. The staple business of this road was originally mineral traffic, a number of iron and zinc mines, as well as limestone quarries, being located in its vicinity, but of late years the romantic scenery of the Kittatinny Mountains has attracted visitors and tourists, and before long it will be one of the most popular resorts on the D., L. & W. R. R. It joined the M. & E. R. R. at Waterloo soon after the extension to Hackettstown was built, but was worked as an independent road, its first superintendent being Thomas Hewitt. The grades and curvature of this line are somewhat unfavorable, but in its early days the trains were light and handled with comparative ease.

When the road was being built the company bought two second-hand engines from the Erie Railroad Co.; they were named "Ramapo" and "New York," and were originally owned by the Paterson & Ramapo Railroad, which had the standard gage. In the year 1851 the Erie Rail-

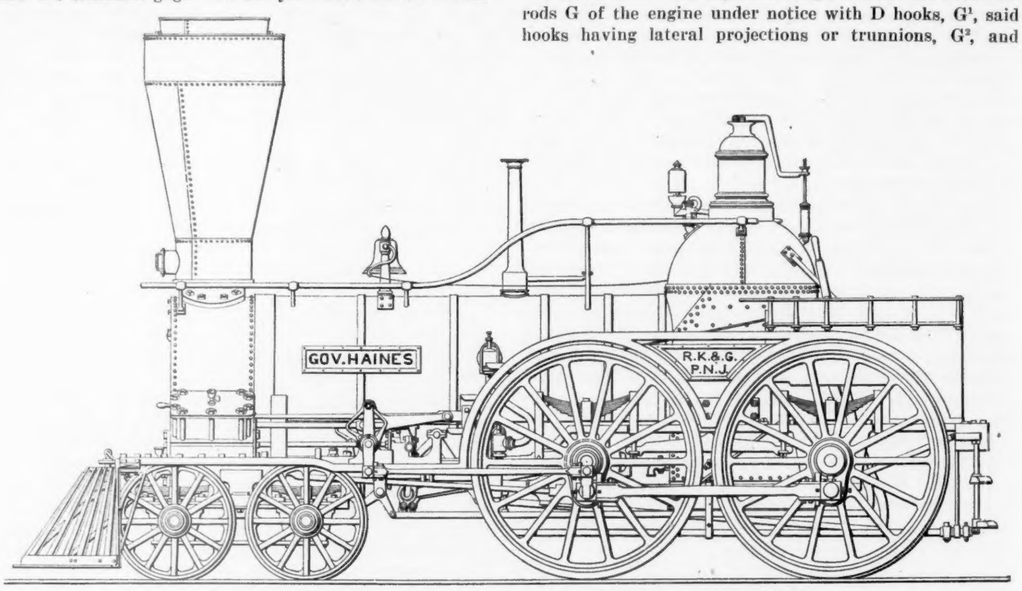


Fig. 10.—Sussex Railroad of New Jersey Passenger Engine, 1854.

road Co. bought this road and changed its tracks to conform to their broad gage, which threw the standard gage rolling stock of the Paterson & Ramapo Railroad out of use and the two engines mentioned were sold to the Sussex Railroad. Both engines were built by Rogers, Ketchum & Grosvenor, the shop numbers being 142 and 143 respectively. They were delivered to the Paterson & Ramapo Railroad on Sept. 11, and 21, 1848, the price of the "Ramapo" being $8,475, but the "New York" cost $100 more.

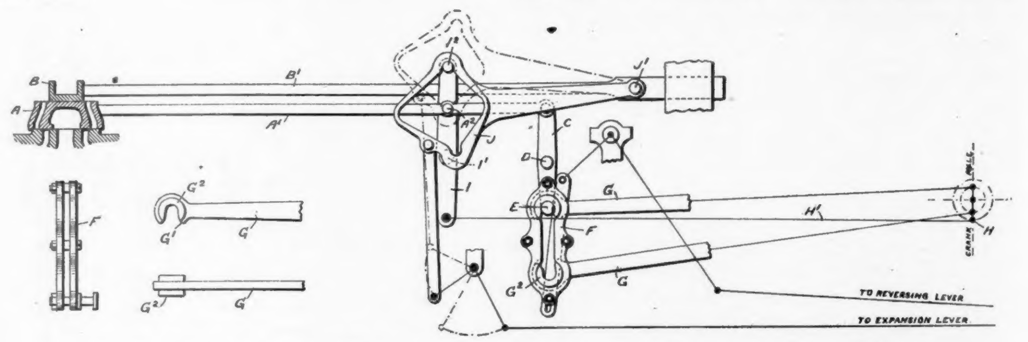


Fig. 11.—Sussex Railroad of New Jersey—Detail of Valve Gear, Engine "Gov. Haines," 1854.

When the engines were received by the Sussex Railroad they were re-named "David Ryerson" and "Gov. Haines," and the latter engine is shown in Fig. 10. It was an inside connected, full crank engine and the principal dimensions were: Cylinders, 14½ in. diameter by 18 in. stroke; driving wheels, 72 in. diameter; total wheel base, 16 ft. 10 in.; weight, about 18 tons. Soon after the engine was received a cab was built and some minor alterations made.

By far the most interesting part of the engine was the valve gear, which was complicated, and extra views shown in Fig. 11 are subjoined, giving the valve motion in diagram, an edge view of the link and side and plan views of one eccentric rod. The writer is indebted to Mr. David M. Harris for calling his attention to this curious valve motion, as a cursory examination of the general drawing does not reveal it. Mr. Harris was an apprentice in the shops of Messrs. Hewes & Phillips, of Newark, in 1857-58, and assisted in repairing this engine.

Referring to the drawings, we find that the steam was controlled by two slide valves, a main valve A and an expansion valve B. The main valve took steam through a port at each end and cut off constantly at full stroke of the piston. The expansion valve (when in use) traveled on the back and in advance of the main valve far enough to cut off the steam at half stroke. This rate of expansion was not variable. The double slide valve was patented by Isaac Adams, May 17, 1838.

The main valve rod A^1, having a pin A^2, was actuated by the ordinary rocking arm C, fulcrumed at D, the pin E, at its lower end, working in the slot of a link F of what appears to be the Stephenson link motion, but in reality is not. It is curious to note that when the so-called Stephenson link motion was first introduced from England it met with strong opposition from some of the most influential engineers of the day—Baldwin himself being among the number. Rogers, however, fully recognized its merits and built an engine in the year 1849 with the Gooch link motion; in 1850 he built engines with the shifting link, and soon afterwards the latter form of motion came into general use in the United States. But although the link motion was giving satisfaction in England, American engineers still clung to the hook motion with an independent cut off, which, in their opinion, gave better results than the link motion. One objection to the hook motion was that if the engine driver reversed suddenly—especially when the engine was moving—the valve rod pins were likely to get broken off and the hooks damaged.

To overcome this objection Rogers made the eccentric rods G of the engine under notice with D hooks, G^1, said hooks having lateral projections or trunnions, G^2, and connected the eccentric rods with the slotted link, F, made of two plates held together by four bolts and thimbles and having circular openings in each end for the reception of said trunnions, G^2. It will thus be seen that the slotted link held the two hooks apart at their proper distance, and in the operation of reversing served to guide the rocker arm pin E without jar into the top or bottom hook; so that, in the words of an old engine driver who has spent many a day (and night) on this engine, "She hooked in easy." The reversing lever was on the right hand side of the footplate and had three notches, "forward," "backward," and "out of gear."

Returning, now, to the cut-off gear, the valve B with its action has been already described; it was operated by a return crank H on the driving wheel crank pin, with a connecting rod H^1 to the usual rocker arm I fulcrumed at I^1. The upper part of this rocker arm had a pin, I^2, which, when the expansion valve was in operation, as it is shown in Fig. 10, and in full lines in Fig. 11, engaged a notch or gab in the upper part of a double V-shaped yoke J; this yoke was raised and lowered by rods and levers clearly shown in the drawings. It was pivoted at J^1 to a rectangular or flattened extension of the expansion valve rod B^1, said extension running in a guide bolted to a bracket which can be seen just behind the driving wheel guard. It is obvious that the opening in the yoke J permitted the pin A^2 on the main valve rod to work independently and clear of it, but when it was desired to run the engine at full stroke the yoke was raised, as shown in broken lines, bringing its lower gab into engagement with the pin A^2, thereby causing the expansion valve to travel synchronously with the main valve in the position shown in the diagram. The pin I^2 being then free and clear of the yoke, the cut-off valve was thus inoperative.

The lever for working this gear, which was on the fireman's side of the footboard, had two notches, one for "in gear," the other for "out of gear." The engine was

started at full stroke, and when fairly under way the cut-off was thrown into operation.

The late Mr. Watts Cooke informed the writer that when he was an apprentice in the shops of Rogers, Ketchum & Grosvenor he assisted in the erection of this engine, and that Rogers did not originate this "link-hook motion," but constructed it from engravings appearing in an English book. A search has revealed that this motion was used on the North British Railway in 1845, illustrations appearing in the *Practical Mechanic and Engineers' Magazine* for May, 1846, and the *Engineers' and Mechanics' Assistant*, London, 1853.

Since August, 1881, the Sussex Railroad has been operated by the D., L. & W. R. R. Co., but separate accounts are kept of the earnings, expenses, and traffic operations of this road.

Returning now to the M. & E. R. R., we find that on July 1, 1856, a short road called the Newark & Bloomfield Railroad was opened. It was chartered March 26, 1852, but for some reason work was not commenced until 1855. It was leased to the M. & E. R. R. at an annual rental of 6 per cent. on the capital stock. The first engine for this line was the "Bloomfield," built by the New Jersey Locomotive & Machine Co., of Paterson, but no drawings of it can be found. Of late years the suburban traffic on this branch has been heavy, requiring powerful engines to haul the passenger trains up the 90-foot grade to the beautiful city of Montclair.

In the year 1857 the Hoboken Land & Improvement Co., of which Edwin A. Stevens was a prominent director, built a line from Hoboken to Newark, making a contract with the Erie Railroad Co. for the use of their Bergen Tunnel.

The Legislature of New Jersey seems to have passed an act in the same year, granting a permit to the M. & E. R. R. Co. to build an identical road and to make such agreements with Stevens, the Hoboken Land & Improvement Co., and the New Jersey Railroad & Transportation Co. as might be approved for running trains between Newark and Hoboken. The outcome of these complicated transactions was that Stevens ran local trains between East Newark Junction and Hoboken Ferry until the Morris & Essex agreement with the N. J. R. R. & T. Co., previously mentioned, expired in 1863, and in the interim Stevens, having bought a controlling interest in the M. & E. R. R., then sold the Hoboken line to them and M. & E. trains commenced running to Hoboken over the Passaic river bridge, which they purchased from the N. J. R. R. & T. Co. Thus the railroad at last reached tide water at its own terminal.

In 1863 the company possessed 11 engines and 114 cars, and during that year 473,205 passengers had been transported without loss of life or limb.

On Feb. 18, 1863, the company sustained a great loss in the destruction of their engine house, machine shop, carpenter's shop and wood sheds by fire. These buildings stood between Broad and Plane streets, Newark, on land now occupied by the City Armory. The engine house contained the engines "Hudson," "Pequest," "Passaic" and "Orange," and the flames spread with such rapidity that all efforts to get them out were unavailing. They were so far damaged that they had to be entirely rebuilt, except the "Orange," which was put on the scrap heap, and thus came to an end the company's first locomotive.

Mr. Thomas Keenan ran this engine many times and regrets he did not buy it when it was scrapped, for it would have been a most interesting relic of the past. He states that when he ran the "Orange," in 1857, the turntables were so small that engines and tenders had to be turned separately, and, there being no water tanks between Dover and Hackettstown, he was often obliged to replenish the tank by buckets of water from the Morris Canal.

During the period under notice the company were developing their coal traffic and the first load of coal was hauled from Easton to New York in 1865. The coal trains were stored at Chatham and from there run "wild cat" to Hoboken, the passenger engines being used for that purpose. Thus, engine men arriving at Summit on their last run were in fear of being ordered to go to Chatham and take in a coal train. The empty coal cars were hauled back attached to passenger trains. In 1868 the "wild cats" were abolished and regular coal trains put on, for the reason that in October of that year a coal train ran away down the fateful Newark Hill. The engine driver, Nathaniel Nichols, stuck to his post, doing his best to stop the train, but told the fireman to jump, which he did. As no train was expected at that time a misplaced switch caused Nichols's engine to strike another engine that was drilling out a car from the paint shop on Spring street. The collision was violent, causing the tender of Nichols's engine to lift into the cab, pinning him against the boiler head, where he was smothered and roasted to death.

During this time the traffic was apparently too heavy for the facilities and equipment the company had at their command, for one of the old-time conductors relates that it took 24 hours to make a round trip with a second-class train from Hoboken to Phillipsburg, and the exhausted crew often went to sleep when the train was on switches. Many fatal accidents occurred, and applicants for work were generally told by the superintendent or despatcher to wait until the next train arrived, when he would ascertain from the conductor if any of his crew had been killed or injured in making the trip.

In order to avoid the steep grades of the original line the company obtained (March 23, 1865) a grant to build a railroad "adapted to the transportation of coal and other produce," commencing from the main line at or near Denville, and thence by way of Boonton through the Great Notch in the First Mountain, and connecting with the Bloomfield Railroad, with the power to construct a branch to Paterson. The railroad constructed under this act was afterwards known as the "Boonton branch" or "cut off" and will be referred to in due course.

In 1867 the road was completed from Hackettstown to Phillipsburg and the track was built to the standard gage, the old 4 ft. 10 in. gage having been changed in 1866. In this year permission was obtained to increase the capital stock to an amount not exceeding $10,000,000.

(To be continued.)

A Problem in Railroad Curves.

BY MALVERD A. HOWE.*

Given a circular curve and the angle, made by a straight line intersecting the curve, with the tangent to the circular curve at the point of intersection, it is required to find the location of a given frog so that the circular curve and the straight line may be connected by a circular curve of a given radius.

In Fig. 1, let AB be the circular curve of known radius R (using for convenience the radius of the gage line of the rail in which the frog is placed) and AE any straight line cutting the curve at A and making the angle β with the tangent to the circular curve at this point. The given frog has an angle F and a wing length ω, then this frog must be placed at some point B in order that the curve DE shall have the radius R' (using the gage line as before).

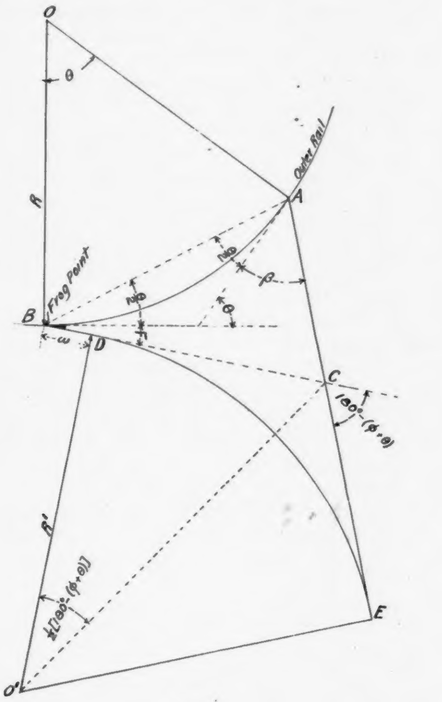


Fig. 1.

Assume that the point of frog lies in the circular curve and that the straight wing is tangent to the curve. This means that the curve between A and B must be thrown a little to adapt itself to the new condition. Let the sum of the known angles F and β be represented by φ, then the value of he angle θ can be found from the triangle ABC as follows:

From the triangle ABC.

$$2\,R\sin\tfrac{1}{2}\theta : \omega + R'\tan\tfrac{1}{2}[180^\circ-(\phi+\theta)] = \sin[180^\circ-(\phi+\theta)] : \sin(\beta+\tfrac{1}{2}\theta) \quad \ldots\ldots(1)$$

Now,

$$\tan\tfrac{1}{2}[180^\circ-(\phi+\theta)] = \frac{\cos\frac{1}{2}(\phi+\theta)}{\sin\frac{1}{2}(\phi+\theta)},$$

$$\sin[180^\circ-(\phi+\theta)] = 2\sin\tfrac{1}{2}(\phi+\theta)\cos\tfrac{1}{2}(\phi+\theta),$$

and

$$\sin(\beta+\tfrac{1}{2}\theta) = \sin\beta\cos\tfrac{1}{2}\theta + \cos\beta\sin\tfrac{1}{2}\theta.$$

Substituting these values in (1) it becomes,

$$R\sin\tfrac{1}{2}\theta[\sin\beta\cos\tfrac{1}{2}\theta + \cos\beta\sin\tfrac{1}{2}\theta] = \omega\sin\tfrac{1}{2}(\phi+\theta)\cos\tfrac{1}{2}(\phi+\theta) + R'\cos^2\tfrac{1}{2}(\phi+\theta) \quad \ldots\ldots(2)$$

Replacing $\sin\frac{1}{2}(\phi+\theta)$ and $\cos\frac{1}{2}(\phi+\theta)$ by $\sin\frac{1}{2}\phi\cos\frac{1}{2}\theta + \cos\frac{1}{2}\phi\sin\frac{1}{2}\theta$ and $\cos\frac{1}{2}\phi\cos\frac{1}{2}\theta - \sin\frac{1}{2}\phi\sin\frac{1}{2}\theta$, equation (2) becomes,

$$R\sin\beta[\sin\tfrac{1}{2}\theta\cos\tfrac{1}{2}\theta] + R\cos\beta\sin^2\tfrac{1}{2}\theta =$$
$$+\,\omega\left\{\begin{array}{l}+\sin\frac{1}{2}\phi\cos\frac{1}{2}\phi\cos^2\frac{1}{2}\theta + \cos^2\frac{1}{2}\phi\sin\frac{1}{2}\theta\cos\frac{1}{2}\theta \\ -\sin\frac{1}{2}\phi\cos\frac{1}{2}\phi\sin^2\frac{1}{2}\theta - \sin^2\frac{1}{2}\phi\sin\frac{1}{2}\theta\cos\frac{1}{2}\theta\end{array}\right\}$$
$$+\,R'\left\{\begin{array}{l}\cos^2\frac{1}{2}\phi\cos^2\frac{1}{2}\theta - 2\cos\frac{1}{2}\phi\sin\frac{1}{2}\phi\sin\frac{1}{2}\theta\cos\frac{1}{2}\theta \\ \qquad + \sin^2\frac{1}{2}\phi\sin^2\frac{1}{2}\theta\end{array}\right\} \ldots(3)$$

Remembering that $\cos^2\frac{1}{2}\phi - \sin^2\frac{1}{2}\phi = \cos\phi$ and $2\cos\frac{1}{2}\phi\sin\frac{1}{2}\phi = \sin\phi$, equation (3) may be put into the following form.

$$+\sin^2\tfrac{1}{2}\theta\,\{R\cos\beta + \tfrac{1}{2}\omega\sin\phi + \tfrac{1}{2}R'\cos\phi - \tfrac{1}{2}R'\}$$
$$+\cos^2\tfrac{1}{2}\theta\,\{-\tfrac{1}{2}\omega\sin\phi - \tfrac{1}{2}R'\cos\phi - \tfrac{1}{2}R'\}$$
$$+\sin\tfrac{1}{2}\theta\cos\tfrac{1}{2}\theta\,\{R\sin\beta - \omega\cos\phi + R'\sin\phi\} = 0 \quad \ldots(5)$$

*Professor of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Indiana.

Dividing (5) by $\cos^2\frac{1}{2}\theta$ it becomes a quadratic equation from which $\tan\frac{1}{2}\theta$ can be found. Its value is

$$\tan\tfrac{1}{2}\theta = -\frac{A}{B} \pm \sqrt{\frac{C}{B} + \left(\frac{A}{B}\right)^2}$$

in which

$$A = R\sin\beta - \omega\cos\phi + R'\sin\phi$$
$$B = 2\,R\cos\beta + \omega\sin\phi + R'\cos\phi - R'$$
$$\text{and } C = \omega\sin\phi + R'\cos\phi + R'$$

For any particular case the values of A, B and C can be easily computed and then the value of θ determined. Knowing the value of θ the location of B or the point of frog is a simple matter.

In case the wings of the frog are curved to the radii R and R', ω and F become zero in the above expressions.

A somewhat shorter but indirect solution of this problem can be obtained from Fig. 2.

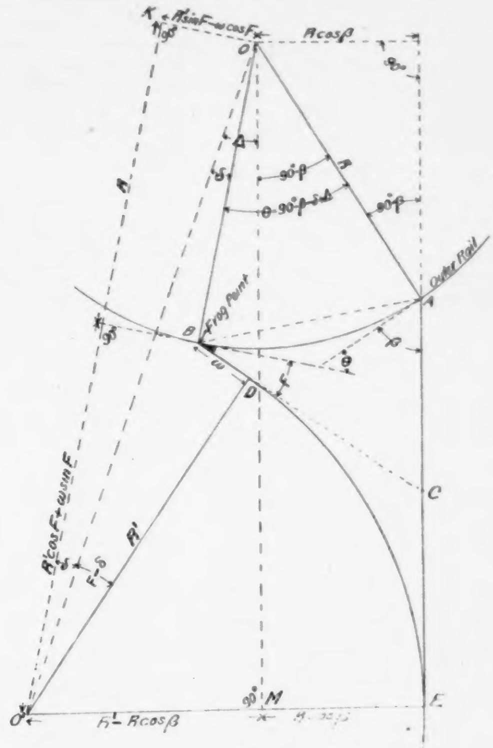


Fig. 2.

From the triangle O O' K.

$$\sin\delta = \frac{R'\sin F - \omega\cos F}{\sqrt{R^2 + R'^2 + \omega^2 + 2\,R\,(R'\cos F + \omega\sin F)}}$$

From the triangle O O' M.

$$\sin\Delta = \frac{R' - R\cos\beta}{\sqrt{R^2 + R'^2 + \omega^2 + 2\,R\,(R'\cos F + \omega\sin F)}}$$

From these equations the values of δ and Δ can be found.

From the figure

$$\theta = 90^\circ - \beta - \delta + \Delta$$

If $\omega = 0$, then $F = 0$, $\sin F = 0$, $\cos F = 1$ and $\delta = 0$

Hence $\sin\Delta = \dfrac{R' - R\cos\beta}{R + R'}$

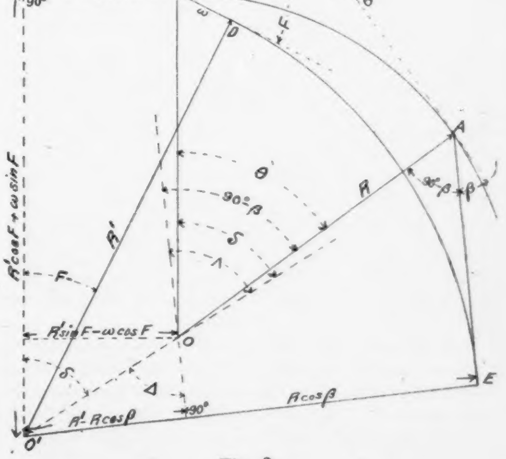


Fig. 3.

In case the curves turn in the same direction as shown in Fig. 3 the above equations become

$$\sin\delta = \frac{R'\sin F - \omega\cos F}{\sqrt{R^2 + R'^2 + \omega^2 - 2\,R\,(R'\cos F + \omega\sin F)}}$$

$$\sin\Delta = \frac{R' - R\cos\beta}{\sqrt{R^2 + R'^2 + \omega^2 - 2\,R\,(R'\cos F + \omega\sin F)}}$$

$$\theta = 90^\circ - \beta - \Delta + \delta$$

If $\omega = 0$, $\delta = 0$ and,

$$\sin\Delta = \frac{R' - R\cos\beta}{R - R'}$$

RAILROAD GAZETTE

ESTABLISHED IN APRIL, 1856.
PUBLISHED EVERY FRIDAY
At 32 Park Place, New York.

EDITORIAL ANNOUNCEMENTS.

CONTRIBUTIONS—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies in their management, particulars as to the business of the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and railroads, and suggestions as to its improvement. Discussion of subjects pertaining to ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

ADVERTISEMENTS—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.*

The Supreme Court on the Stock Yards Case.

The decision of the Supreme Court of the United States in the suit of the Interstate Commerce Commission, to compel compliance with its order reducing the charge for delivering cars of cattle to the Chicago stock yards, is based on such a complicated mass of facts that we cannot think of giving a full abstract of it within any reasonable compass, and to those readers who are not familiar with the litigation we must recommend the perusal of the full decision (No. 154, October Term, 1901). But for those who have followed the previous decisions on this long pending question we will try to summarize the main points of the present opinion.

For 30 years, up to 1894, the railroads entering Chicago from the West had delivered cars of live stock to the stock yards without any extra charge above the regular Chicago rate. In 1894 the Stock Yards Company began to make the railroads pay a charge, averaging one dollar a car, for the use of its tracks, and thereupon the railroads imposed a charge of two dollars a car on the consignees. One of these roads was the Atchison, which was in the hands of a receiver, and the Court, being applied to, ordered Receiver Walker not to exact the additional two dollars; but the Circuit Court of Appeals, to which the case was taken, reversed this order, thus permitting the charge to be made.

After this, the Cattle Raisers' Association of Texas asked the Interstate Commerce Commission to order the two-dollar charge discontinued, because it was unreasonable and was a discrimination in favor of other cattle markets. In the proceedings before the Commission the railroads claimed that for 30 years they had done the delivery service for nothing, and hence that two dollars was only a reasonable new charge. Moreover, at the time the complaint was made, the rates from Texas (and other places) were unreasonably low, having been forced down by competition.

The Commission held that the road collecting the freight bill could lawfully divide the rate; that is, could make a terminal charge separate from the regular transportation rate; so the question was, Had they thus divided and if so, had they done it fairly? It was held that two dollars, for delivery, was in itself fair; but that the railroads were already charging something for delivery; their claim that it was done gratuitously was not sound. Hence they were now charging two dollars plus a part of the former through rate. When the stock yards imposed the trackage of one dollar the roads should have added only one dollar to their price. The roads did not comply with this order, and the Interstate Commerce Commission went to the Circuit Court. This court dismissed the Commission's petition because two dollars was held to be a reasonable price.

The Supreme Court now holds, in substance, that the Interstate Commerce Commission was right in the principles which it applied, but that the facts of the case were not accurately diagnosed. Therefore, the order which was made by the Commission is not sustained. The railroads have the right to separate the terminal charge from the rate for transportation proper. The claim that the railroads performed the delivery service for thirty years gratuitously is rejected; it must be assumed that the through rate, collected during all these years, covered all of the service performed by the railroads. When the two dollars was added the rate already existing was not divided. "On the contrary, the entire previous through rate was retained, and a memorandum was placed upon the schedules to the effect that thereafter an additional charge of $2 for delivery at the stock yards would be exacted. This was a mere addition to the sum of the terminal charge embraced in the prior through rate. We think that it cannot be said that to add an additional amount to a former charge was necessarily to divide such former charge, without holding that to add one sum to another is necessarily to divide the other" . . . "The $2 did not constitute the terminal rate, but such rate after the $2 was imposed consisted of that sum plus the amount of compensation for the terminal service which had always been contained in, and which continued to be embraced in, the through rate." The addition of one dollar by the stock yards did not justify the railroads in adding another dollar. Thus the Commission is sustained.

But this ignores the fact that in 1896 live stock rates from Texas and other regions were radically reduced; the reduction amounting to ten dollars or more a car. The Commission held, at first, that the terminal rate was unjust because of the addition of one dollar. This decision was based on a ruling that the through rate must be excluded from consideration; but, at the same time, the Commission had found that two dollars was less than the cost of the terminal service; and the terminal rate, therefore, was reasonable only when taken in connection with the through rate. Having done this the Commission was then bound not to ignore a reduction in the through rate. "As the finding was that both the terminal charge of $2 and the through rate as reduced, when separately considered, were just and reasonable, and as the further finding was that as a consequence of the reduction of ten dollars per car, the rates, considered together, were just and reasonable, it follows that there can be no possible view of the case by which the conclusion that the rates were unjust and unreasonable can be sustained." This disposes of the case; but the Supreme Court finds further, from the Commission's record, that the reduction of ten dollars a car did not apply to all of the territory under consideration, so that it is impossible to tell just what traffic the Commission's order ought to be applied to, if it were to be applied. And there is still another difficulty. The Commission at first found that both the through rate and the terminal rate, separately considered, were each just at the time the complaint was filed; but in another decision, after reargument of the case before the Commission, it is said that the ten dollar reduction, applying only to portions of the territory, had been made to equalize rates from different sections. This produces a conflict in the statements, and it appears that in substance the Commission holds "That the rates separately considered were just and reasonable at the time the complaint was filed, and yet that some of the just and reasonable rates were unequal, and hence unjust, and required to be changed in order to remove the inequality, and therefore the unreasonableness which existed in them." The Court is unable to separate the reasonable from the unreasonable rates, and therefore cannot sustain the Commission's order even in part. The decision of the lower courts refusing to enforce the Commission's order is affirmed; but the Commission may, if it deems best to do so, begin proceedings to correct any unreasonableness in the rates on live stock from points where the ten-dollar reduction did not apply.

We have thought best to give the points of this decision somewhat in detail because, by reason of the numerous and varied questions connected with the subject and the fact that several tribunals have already dealt with it, many readers have become familiar with it; but aside from this there is a general consideration which deserves passing notice. It is the fact that the Supreme Court and the Interstate Commerce Commission agree in forbidding the railroads to embrace a favorable opportunity to make a small advance in a rate. These two bodies agree that, cattle having been carried at a certain rate for 30 years, that rate is therefore conclusively reasonable. **As every railroad man knows, a commodity is sometimes carried for years at rates unreasonably low—many passengers are thus carried all the time—but from these and other decisions it is clear not only that possession is nine points of the law, but that possession (by the shippers) of a low tariff for a series of years is pretty sure to be deemed by the courts to be 10 points—the whole thing. We have no doubt that all of the railroads were not only sincere, but intelligent and earnest, in their assertion that the stock yards delivery service had been performed for nothing—but it is evident that the judicial habit of thought does not apprehend any such idea as that.**

Reports of the Master Car Builders' Convention.

On another page will be found pretty copious extracts from the reports presented at the Master Car Builders' Convention at Saratoga. For the greater convenience of some of our readers we make a short digest below, of a few of the most important points in these reports.

Standard Methods of Cleaning Triple Valves and Cylinders and Prices.—The detailed directions for cleaning and testing are doubtless useful suggestions. In fixing the schedule of prices the committee has made a key of prices covering 17 items. These key prices were then applied to the different parts in detail, making up a very thorough schedule. Finally, the committee recommends that the price for air-brakes be made $27.50. We have no means of judging how far the schedule of prices will be acceptable to the Association. Doubtless it will be the subject of considerable discussion; but, at any rate, it is a judicious effort at fixing standards.

The Examination of Car Inspectors.—This report although short, only three pages, is of considerable value. The importance of careful examination of car inspectors and particularly of testing their vision, is pointed out. This has been a favorite topic with the Chairman of the Committee for some time, and he is undoubtedly correct in his notion. A man who cannot see well without glasses is badly handicapped as a car inspector. The Committee recommends that no new men shall be taken on for this work who are more than 30 years old, and none promoted who are more than 40 years old. Those who are inclined to think that the Committee has contributed a new word to the English language in "acuity" should stop and look at the unabridged dictionaries.

Draft Gears.—This report contains a description of apparatus and methods of test, all of which have been printed by us in times past. The committee draws practically no conclusions, except that a series of road-tests is necessary in order to carry out the instructions of the Association. Records must be kept for a given period of repairs necessary to the draft gear and to other parts of the car, also of car mileage and tons hauled, and it is recommended that a committee be appointed to carry such tests to a conclusion. The bulk of the report is a record of tests from which it would be impracticable to draw any valuable comparisons except by careful study and analysis of the individual tests, such as we have not yet been able to make..

Side Bearings and Center Plates.—The subject undertaken by this committee is of quite unusual breadth of interest. It interests the master car builder as it affects the construction and life of various parts; it interests the superintendent of motive power and the general manager in that it affects not merely cost of maintenance but cost of hauling; it interests the engineer of maintenance of way in that it affects the life of rails; it interests the maker of cast-iron car wheels, as the question of the endurance of car wheels under 50-ton cars is closely related to this matter of side bearings, and finally, it interests the builder of the steel car himself, for it has a close relation to the life of the bolster. Within the last two years we have seen many pressed steel bolsters broken in such a way as to indicate that they were bent transversely by the resistance of the truck to curving. The Committee concludes that its observations do not justify any attempt to settle upon design of center plates or of metal for center plates and asks to be continued for another year,—a most wise conclusion. It concludes that from the opinions collected it is impossible to decide as to the propriety of using side bearings to carry part of the load, but is of the opinion that the load can be carried and should be carried on the center plate. Nevertheless, the Committee concludes that the resistance between wheels and rails is much diminished by the use of anti-friction side bearings. So far as the Committee has gone then, we may say that the bolsters should be stiff enough to carry the load on the center plate, but that the load is bound to be thrown upon the side bearings, without any deflection of the bolsters, and that therefore, to relieve the truck in curves there should be anti-friction side bearings.

Outside Dimensions of Box Cars.—The Committee recommends that the inside dimensions as approved by the American Railway Association, namely, 36 ft. x 8 ft. 6 in. x 8 ft., be submitted to letter ballot as standard. Also that the following outside dimensions be submitted to letter ballot, namely, box cars on high trucks, 12 ft. 6¾ in. x 9 ft. 7 in.; on low trucks, 12 ft. ¾ in. x 9 ft. 7 in. The Committee also recommends that a committee be appointed to devise standard framing for box cars.

Standard Pipe Unions.—The Committee on this subject presents as its report the recommendations made to the American Society of Mechanical Engineers by a committee of that body, and recommends for adoption as standard the dimensions arrived at by the Mechanical

Engineers' committee. This latter committee took up first the matter of uniformity in threads of coupling unions, and quickly discovered that the product of the principal manufacturers was entirely without uniformity, in fact, "there was absolutely no two alike." But the dimensions of the threads affect the other dimensions, and it was decided to take up the entire coupling union, and a study was made of unions for all sizes of pipe from ⅛ in. to 4 in. inclusive. Details were worked out under the personal direction of Mr. Vogt. In course of time the details were submitted to 11 manufacturers, two of whom replied making suggestions. The drawings were revised and sent out again, and no replies received; which is another illustration of the difficulty of standardizing such articles of large manufacture. On the face of it, we should suppose that the Master Car Builders' and Master Mechanics' Associations cannot do better than to adopt as standards the designs reached by the Mechanical Engineers' committee, namely, Messrs. Herr, Vogt, Baldwin, Bond and Flagg.

The Railroads of Denmark.

As long ago as 1898 a commission of members of Parliament and administration officers was appointed in Denmark to report on the State Railroads, their organization and changes desirable in their policy. This commission has but recently reported, and during its existence important changes have occurred in the results of the workings of the State Railroads. Reduced rates went into effect in 1897. In 1895 the net earnings had been 5,202,000 crowns ($1,394,135); they fell to 2,-399,000 crowns in 1899 and to the insignificant amount of 330,000 crowns ($88,440) in 1900. The Commission, however, does not attribute the decrease in net earnings to the reduction in rates, but to an increase in expenses, largely unavoidable. The traffic increased 50 per cent. from 1895 to 1900, and the gross earnings, 32 per cent.; but meanwhile prices of almost all materials and supplies (nearly all imported) increased greatly, coal no less than 122 per cent. Wages also have been increased. The Commission thinks this increase of expenses warrants an increase in rates, and it proposes a new tariff, which, as its main features, shows an advance of about 7 per cent. in passenger fares of all classes, and an increase of one-ninth in freight rates.

It also proposes a new organization for the railroad administration, and submits a plan for profit-sharing with the employees, by which it is hoped to secure greater economy in operation. For this purpose, the employees would be divided into 15 classes, and their part of the net earnings into 12,000 shares. To each class of employees a certain number of these shares is assigned; 700 shares to the trainmen, for instance. The employees first get a share of the profits when they exceed 2 per cent. on the capital invested. When the profit is between 2 and 2½ per cent. they will have one-half of the excess over 2 per cent., and smaller proportions of greater profits; should they be between 4 and 5 per cent., only 5 per cent. of the excess.

The organization proposed gives the general management to a corps of five officials, one presiding and each of the other four at the head of a department (operation, road maintenance and construction, rolling-stock, accounts and rates) the presiding officer, whom we may call General Manager, is to have a salary of 10,000 crowns ($2,680), rising 1,000 crowns every three years till it reaches 13,000 ($3,484); the four heads of departments begin at $1,930 and rise to $2,573. Division superintendents receive $1,206 to $1,688, etc.

It remains for Parliament to accept, modify or reject this plan; but with less than $90,000 net earnings from more than a thousand miles of railroad, it would seem that something ought to be done.

Officers of the Baltimore & Ohio have held another meeting, about 150 of them gathering at Deer Park, Md., in the company's hotel, on Friday and Saturday, June 13 and 14. The subject for discussion was the per diem plan for car-service settlements, and Mr. Midgley made an address, using some of the statistics that he has lately been gathering, and presenting figures showing what a great saving ought to be made by the adoption of this reform. This address was given on Friday. On Saturday there was a general discussion of the subject, from the practical standpoint. Most of the men who were present will have something to do with putting the change into effect on the first of next month. There were present the General Manager, the Assistant General Manager, and the General Manager's staff; the General Superintendents, Superintendents, Division Engineers, Master Mechanics, Trainmasters and a number of Agents from the principal stations. The chief officers answered a multitude of questions presented by their subordinates. This is the second meeting of this kind which has been held since the present administration took charge of the Baltimore & Ohio, and it is regarded as a decided success. It would appear that to own a summer hotel with a large ball-room is one of the best investments that a railroad company can have. Evidently Mr. Loree believes in making gatherings of this kind answer the purposes, social and other, of what on other roads has taken the shape of an officers' association or an annual track inspection. He makes an improvement on the usual plan, however, by devoting a given meeting to a single department of the work. The meeting last autumn, at Cumberland, was made up of men from the Maintenance of Way Department, the topic for discussion being the preservation of timber; although then, as now, the exchanges of ideas outside of the formal discussion constituted a valuable feature of the meeting. This last meeting, it will be noted, was composed of transportation men. It is proposed to devote the next meeting chiefly to the motive power men.

In connection with the subject of per diem, the reader will observe that the names of the roads which have signed per diem agreements are given in a list which is printed in another column of this paper. Since that list was made the Southern Railway has signed, together with others which bring the total number of signatures up to 195, representing 1,345,000 cars. We also understand that the Trunk Lines have decided to allow the New England roads to withdraw from the joint eastbound tariffs on cotton. Officers of the roads centering at Cincinnati met in that city last week and adopted an agreement for dealing with freight cars to be handled by switching roads. The agreement is based on the following supplement to Rule 5 of the A. R. A. Car Service Rules: "The delivering road will allow final switching road, upon whose rails cars are unloaded, or upon private tracks connecting with their rails, or upon empty cars delivered for loading, 80 cents per car, to cover all time for reclaim and reloading of cars delivered under load." The Superintendents' Association of Texas held a meeting at Houston, June 10, and considered same subject. It was voted that three days should be the basis on which reclamation may be made against the delivering line for cars switched. It was also agreed that in view of the arbitrary allowance of free time by the Car Service Association at Galveston, an allowance of five days reclamation should be made on all export stuff passing from or via Houston to Galveston, said reclamation to be restricted to Texas products and upon the lines bringing traffic to Houston for Galveston. This was in the nature of a concession to the short Galveston lines, the Galveston, Houston & Northern and Galveston, Houston & Henderson, to allow for their short haul and small percentage of earnings. This arrangement is to be operative for six months.

Progress in Locomotive and Car Shop Plans.

During the past year a number of large railroad shops have been built, which embody new and interesting features, and they are so much superior to the old-style shops in many ways that some reference to them may be profitable. The marked peculiarity of these new shops is the concentration of several of the principal departments in one large building. The prototype of these long buildings when used for locomotive shops is doubtless the immense shop of the Lancashire & Yorkshire Railroad at Horwich, England. Here are two shops each 1,500 ft. long, 111 ft. wide. In one, the erecting shop, is found capacity for repairs to 100 locomotives at one time. In the other building are concentrated all the departments in which iron or steel is used in a heated state, including the boiler shop, smith and forge shop, steel foundry and iron foundry. The Oelwein shops of the Chicago Great Western were the first in the country to concentrate all departments for locomotive repairs in one long building on one side of the transfer table, and all the car repairs on the other side.

This plan has been followed at Hannibal in the new shops for the Hannibal & St. Joseph, and the new Fond du Lac shops of the Wisconsin Central, these three shops being quite similar in general arrangement.

In the new Hannibal & St. Joseph shop at Hannibal the large building on one side of transfer table, combines the smith shop, boiler shop, the machine shop, erecting shop, power house and boiler house, all in one. This building is 439 feet long and 102 feet wide. The erecting shop and boiler shop section is 290 feet long. A part of the width, 65 ft., is spanned by an electric crane of 15-ton capacity. The remainder of the width of the building is in two stories, the lower story for the heavy machine tools, the upper story for patterns, pipe machinery, air-brake and link repairs. The other large building on the opposite side of the transfer table combines the paint shop, car repair shop and planing mill.

In the machine shop there are 40 tools driven by 29 motors aggregating 172 h.p., and in boiler shop five motors having a total of 60 h.p.

The advantage of subdividing and using individual motors is clearly shown in the results obtained at this shop; with a total capacity of 700 h.p. of motors the maximum switchboard load has not exceeded 200 h.p. or less than 30 per cent. This low ratio could not possibly be obtained with a system of shafting; in fact it is very unusual to have the above per cent. as low as 33. With the best system of shafting, the horse-power would have been 300 instead of 200.

The complete power plant, including foundations and all apparatus in the generating station as well as the distributing system motors, shafting, gear with lighting and all appurtenances erected in place ready to run, was installed at a cost of little less than $90 per connected horse-power, while the power station itself represents a cost of $68 per horse-power.

In regard to the arrangement of the tracks in the erecting shop where electrical cranes are used, there is still quite a difference of opinion, and this is usually based on the particular experience which any one has had. If they are accustomed to shops with longitudinal tracks they would evidently prefer that kind, but if used to one where the tracks are crosswise of the shop, they would prefer that kind.

Where the tracks are placed crossways in modern shops it seems necessary to make the walls very high and to use two runways for cranes so that locomotives can be lifted clear over each other in placing them about the shops. With the longitudinal plan there are usually three tracks having 22 ft. centers, so that it is possible to carry the engines to any desired point between those on adjacent tracks and the higher walls are not required, and cranes on one level are all that is necessary.

One of the largest locomotive works, the Baldwin, has cross tracks, so also has the erecting shop at Schenectady. The Pennsylvania road having used longitudinal tracks in their repair shop at Altoona naturally made a similar plan for their new locomotive shop at Juniata. Again, if we take three of the largest repair shops recently built in this country, we find the same difference in the arrangement of tracks in the erecting shop. The new Lake Shore shops have the tracks crosswise, so also do those in the new Reading shops; both of these shops being very large and having walls arranged for double deck cranes. The new locomotive shop at Elizabethport built by the Jersey Central has erecting shop arranged for three parallel tracks. The advantages and disadvantages of these two different plans will be stated briefly.

In the earlier shops it was a choice between the traveling cranes and transfer tables, each of them really performing the same function, that of transferring engines from one track to another and placing the engine on any particular track in the shop where it was desired to locate it. The transfer table used for both locomotives and cars in the old shop plan became such a familiar institution that it was thought necessary to use it even where overhead traveling cranes were used inside. For locomotive shops which are not combined with the car shops, it would appear that overhead cranes and longitudinal tracks would be the best arrangement, and to dispense entirely with transfer tables. The objections to transfer tables are that they occupy a large portion of the yard room which cannot be used for anything else, which has to be kept clean of snow in the winter, and over which the men are continually walking, and material is being transported in a very inconvenient way. Then they require a large door opening opposite each pit in the erecting shop; these large doors are expensive in the first place; they are difficult to keep in repairs; when opened they expose the shop to large drafts of air, and when shut they are difficult to keep tight, and it is, therefore, difficult to heat the shop.

The objections to cross tracks inside are: they require very heavy cranes where the engine is to occupy a single bridge, while with the longitudinal plan the two lighter cranes can be used, and each of them made available for handling lighter work.

In the recent plans for large shops which combine locomotive and car work and where the buildings concentrate a number of different departments, a transfer table which serves them all may be well justified, but in such cases it must be a first-class, substantial machine, which will not get out of order, for the circulation of engines, cars and materials all depend upon its constant use.

In the two large new locomotive shops, those of the Lake Shore and the Reading, the cross tracks are evidently used on account of the facility with which the driving wheels, trucks, tenders and boilers can be transferred directly from the engines in the erecting shop to their positions directly back of it where they are to be repaired.

The location of shops in the first place should have special reference to opportunities for good drainage, not only of sewerage, but surface water. The water supply itself is also an important element, not only for use in boilers and for drinking purposes, but especially for fire protection, and in the large shops hydrants or hose outlets from water pressure pipes should be located every 200 ft. throughout the length of the shop. It is well to provide through the length of the large shop a pipe tunnel large enough for a man to pass through, at least 3 ft. by 5 ft. clear section, in which the pipes and the wires for electric circuit can be placed. This tunnel would contain all pipes for high pressure steam leading to the outlets in the pits where it can be turned on for testing boilers; also to the hot blast fans where it can be used at night when exhaust steam is not available. There is usually in the tunnel exhaust steam pipes for these fans, water pipes for hydrants and boiler testing, toilet rooms, etc.; also an air pipe of good dimensions for air pressure of about 100 lbs. for operating the various new pneumatic tools, which are now in such extensive use.

The coal station for delivering coal to engines should be operated by electricity, and the requirements should be that it would deliver to an engine 15 tons of coal in 15 seconds at a cost for handling, including interest and depreciation on the plant, of not more than three to five cents per ton.

In modern shops the bulk of the day lighting is obtained from the skylights in the roof, and these are now made of a translucent fabric supported on a fine wire netting. This film is made largely from linseed oil. In the Elizabethport shops the machine and smith shops have 34 per cent. of their roof in skylights made of this material, and the paint and car shops have over 50 per cent. of the roof in similar skylights.

In most of the railroad shops built thus far and operated by electricity, the direct current with a pressure

of 122 volts at the motors has been used. The electrical requirements in the railroad shop combine three different conditions, which are all not exactly suited to either direct or the alternating system. The motors for the machine tools, which are running at nearly constant speed, could be operated by either direct or indirect current. Those for the traveling cranes and transfer tables heretofore have been most successfully operated by direct current motors. While the alternating or induction motors are often used on traveling cranes by the works of the large electric companies, the difficulty of starting them under a heavy load has prevented electrical engineers from recommending them generally for locomotive shops. For the lighting system about railroad shops there is also a mixed requirement in the fact that incandescent lamps are best for individual tools; arc lights for the large areas, and there is often an added requirement in the lighting of the railroad yards, stations, freight houses, roundhouses, etc., some of which may be located one or two miles from the generating station at the shop; and for such long distance lighting, the alternating system is the most economical. We thus have mixed conditions in which the general requirements at the shop are best met by the direct current, while those for the lighting requires the indirect current. On account of the necessity of providing a reserve generator, it is also desirable that the generators in the power house belong to either one or the other type, but two kinds should not be used.

Mr. C. H. Wilmerding, the Consulting Engineer at Chicago, who was the engineer for the installation of the electric plant in the Hannibal & St. Joseph shops and there used the direct current, is now making plans for the electric work to be installed for the Michigan Central shop improvements at Jackson. He has evidently found a solution for the difficulty in starting induction motors and operating motors generally on the alternating system, as the installation for these shops is to be the three-phase alternating system throughout; the pressure being 440 volts on all but the lighting circuits; on these the voltage will be reduced by static transformers. We believe this will be the first railroad shop in this country where the three-phase alternating current is used exclusively. The lighting transmission will extend two miles to a station and will light the yards. The motors will be the General Electric, and their type M will be used for the cranes, transfer tables and turntable. This type of motors was especially designed for frequent starting and heavy loads. The power house will be equipped with three water tube boilers, each 260 h.p., and there will be one 75 k.w. and two 200 k.w. alternating generators, direct connected to compound engines.

The Boston & Maine, in its shops at Concord has, since 1897, operated lights and machinery on the two-phase alternating system.

The Northern Pacific, since 1899, operated their shops at Brainerd on two-phase alternating 220-volt motors and 110-volt lamps. A part of the lighting extends to the freight and passenger station one-half mile, and another to the hospital one mile distant.

The voltage is 220 at generators and this is used on the shop circuit, but is transformed to 2,200 volts for the two lighting circuits and then locally stepped down to 110 volts at the lights.

The alternating current is then used for lights, machine motors, traveling cranes and transfer table, and these severe requirements have been met successfully.

The three most recent railroad shops built on a large scale are the Elizabethport shops of the New Jersey Central, illustrated in the *Railroad Gazette*, Dec. 27, 1901, and Jan. 3, 1902; the new Lake Shore shops at Collingwood, Ohio, and the Reading shops at Reading, Pa.

The Elizabethport shops are intended to maintain 450 locomotives, 16,000 freight cars and 500 passenger cars, and occupy 60 acres of ground. The locomotive shop is 150 ft. by 700, and combines in three bays under one roof the machine erecting shop and boiler shops. The erecting shop is 82 x 700, arranged with three longitudinal tracks with 22 ft. centers. It is spanned by two 80 ft. 50-ton cranes, 35 ft. clearance under the hooks. In the central bay, all the heavy machinery is served by a 10-ton and 5-ton crane; in the boiler shop a special 40-ton electric crane serves the riveter and provides 45 ft. clear space under the crane. In the power house the equipment consists of two 500 h.p. Babcock boilers with space for one more. There are three 100 k.w. direct current 240 volt generators, and space for three more. The generators are direct connected and provision is made for only 30 per cent. of the total h.p. of the motors used throughout the shop with the exception that no deduction is made for the motors used on the large cranes or in the main fans, and the lighting load is figured separately. A large number of individual motors are used and the number of groups is correspondingly small; there are 18 groups and about 80 individual motors, all on direct current with rheostatic control, total number of motors being 98. In the boiler shop the riveters are all operated by compressed air; the largest has a 16 ft. gap. There are three engines, each 175 h.p., running 275 revolutions, and also two air compressors having combined capacity of 2,000 cu. ft. of air per minute.

The transfer table of this shop is the largest ever built, 80 ft. wide, and complete run-way 800 ft., with a speed of 125 ft. per minute when fully loaded, and 275 ft. when light. It has a capacity of 200 tons and is driven by two 25 h.p. motors.

The floor of the erecting shop has first a 12-in. layer of cinders covered by 6 in. of concrete supporting 4 x 4 pine and 2 ft. centers. The spaces between are filled with concrete and take flooring 3 x 3 yellow pine.

The new Lake Shore shops at Collingwood now under construction are nearly completed. This is a combination of a very large car shop and a large locomotive shop. The locomotive shop is intended to take care of 520 locomotives. It is 530 ft. long and 245 ft. wide. The cross section being in four bays, one portion being the erecting shop, the two smaller portions being the machine shop, and the further one for the boiler and tank shop. This is another illustration of the compact concentration of the three principal departments for locomotive repairs in one building and under one roof. It is built on cross track plan, and in order to move engines from one portion of the shop to another, it is necessary to lift them over each other, requiring very high side walls and double-deck cranes. The high cranes over the erecting shop have a capacity of 100 tons, and the low one a capacity of 10 tons. The crane in the boiler shop has a capacity of 30 tons.

We hope to illustrate this magnificent shop and give a complete description of it in a future number.

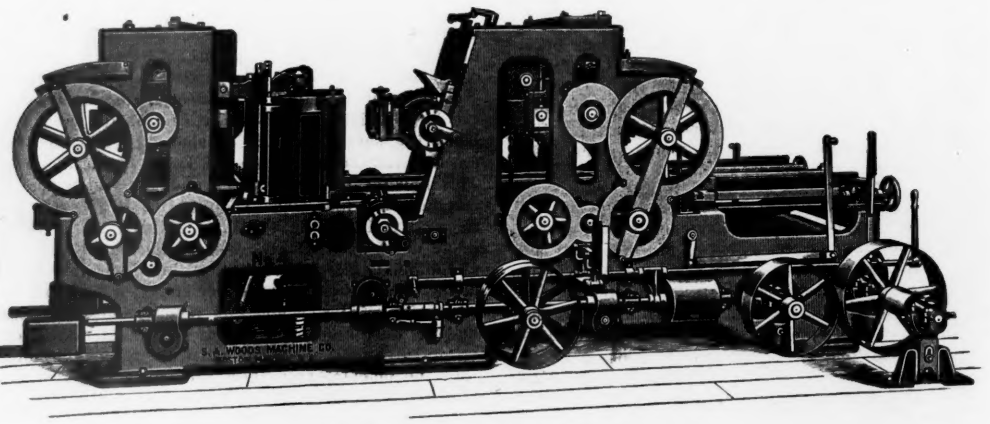
Although the Philadelphia & Reading road has only 913 miles of track, it has 772 locomotives, and its system is so compact that its repair shop for all these engines can be located at one point, and the new shop at Reading is intended to take care of the bulk of this equipment, the present small shops at junction points to be used only for light repairs. The shop has cross tracks sufficient for 50 locomotives. The two side bays are each 69 ft. wide, and the length of the erecting shop is 750 ft., with a height sufficient for double-deck cranes. The clear distance from the floor to the under side of roof truss is 46 ft. 6 in. The cost of these shops, when completed, will be $1,000,000. The fan houses for the heating system are small wings extending beyond the main building and have a low roof; they do not thus occupy valuable floor space in the more costly structure. The air ducts for the heat are also located outside of the main building, and thus illustrate in a very good way the extent to which the heating system affects the plans for shop building, and why they should be considered and settled quite early, and included as a part of the foundation plans. These shops are built on a colossal scale, and represent the most extensive modern locomotive repair shop in this country. W. F.

A New Extra Heavy Timber Sizer or Car Sill Dresser.

The engraving shows a new eight-roll four-sized timber sizer or car sill dresser recently placed on the market by the S. A. Woods Machine Co. It is of entirely new design, with all the mechanical improvements suggested by 50 years of experience in planing mill equipment.

The machine works 30 in. wide by 20 in. or 24 in. thick, and has, among others, the following improvements:

Patented wedge platen adjustment, by which bottom rolls and platen or bed-plate before cut are simultaneously adjusted on inclines, thus increasing or diminishing the cut of the bottom cylinder, as desired. This adjustment is operated by a crank at the feeding in end of the machine from which location the movable parts may also be instantly



A New Timber Sizer or Car Sill Dresser.

locked at four points. This feature resembles the table of a buzz planer, adjustable on inclines, and it allows of instantly adjusting the machine for single surfacing only.

Patented knife setting gages, which eliminate the necessity of other instruments or frequent measurements and insure absolute accuracy. These gages are quick acting and are adjustable to give the desired projection of knife over the lip of the cylinder.

Bottom cylinder with yoke draws out from working side to facilitate access to knives.

Lever locking devices for cylinder yoke and side head frames; these obviate the use of wrenches and save considerable time.

Both cylinders and matcher spindles double-belted.

Simplicity of gearing and strength of feed.

New system of weighted pressure, feed-rolls being all weighted from below and inside of frame.

Center guide of expansion type to give more or less taper, as desired. Adjustable spring lever guides for each side to hold stock to guides.

Surface and side chipbreakers and pressure bars provided with ample expansion to permit of deep grooving.

Convenient location of and easy access to all parts, and superior piping facilities.

This is but one of a large variety of new machines for car shops recently added to the line of wood-working tools manufactured by the above company.

Freight Transfer Houses and Consolidation of Picked-up Freight.

BY EDWIN H. LEA.

Railroads annually expend large sums in moving carload freight by providing fast trains and expensive equipment; though the percentage of expense for handling less than carload freight may be as large in proportion, and even greater than necessity requires, we are not, in my opinion, utilizing this money in the best way.

Personal experience and observation convince me that our present methods of handling L. C. L. freight are imperfect, lacking in systematic co-operation. On agreed tonnage minimums, why should not L. C. L. cars be forwarded under original seals from a transfer or terminal on one line to a transfer on another line? With centrally located transfer stations on all principal roads, the plan would be feasible and worthy of trial; if adopted, junction handling would be largely eliminated, and the centralization of tonnage would facilitate advantageous distribution; cars would move through on card manifest and waybills be handled by train mail. If solid billing is found impracticable to all points, the junction handling of waybills could be continued. We are not progressive. The time in transit on L. C. L. traffic is largely in excess of real necessity. We should provide the requisite means for handling our best paying tonnage more systematically. Time to local points has its influence on business to competitive territory.

Having given this subject some thought, I feel that the following suggestions, carried out as a whole, would materially improve our present L. C. L. service, reward us with reduction of time, cost of handling and in the number of loss and damage claims.

First.—Establish on each railroad one or more general transfer stations and as many subordinate transfers as necessary. These general transfers should have a track capacity of 150 cars. Platforms both sides of every track would obviate the necessity of placing cars of various lengths with doors opposite. This alone means a great saving in time to both yard and transfer forces. Ten tracks side by side will bring all cars within an economical trucking radius. Warehouses should be divided off in division order by swinging center signs and sub-divided into stations by side or wall signs. The accompanying sketch shows the details of a general transfer, arranged to reduce switching to a minimum and facilitate the loading of foreign cars home.

Second.—These general transfers should be at points where the volume of passing tonnage will make consolidation advantageous. This would be no difficult problem to solve. With daily reports of L. C. L. tonnage from principal stations and present transfers for 10 days, close calculation could be made as to the point where traffic currents would warrant the establishing of the consolidation station.

Third.—The direct management of these general transfers should be assigned to thoroughly efficient and practical men, who should rank with division superintendents, for a station will have an important effect on the revenues of a company. His title should be superintendent of transfer. His time will be fully occupied in adjusting the L. C. L. movement to the economic conditions expected. He will make many recommendations as to changes in loading and consolidation, all of which must bear the stamp of intelligent study.

Fourth.—To properly carry out the plan proposed, it would be necessary for the head of the general transfer to report direct to his general superintendent, the idea being to give him the necessary authority to regulate the handling, loading and consolidation in that district, and to also confer through his general superintendent with the heads of other general and sub-transfers, both on his own and other lines.

Fifth.—Agents at sub-transfers should report to the Superintendent of Transfer in their respective districts

on all matters pertaining to transfer work. This would be necessary to bring about uniformity in the general work; and as the superintendent of transfer is to be held responsible by his general superintendent for satisfactory results, he is the one to regulate the loading of L. C. L. freight.

Sixth.—These general transfer stations should be distinct and separate from all other agency work. It will be impossible to get satisfactory results if any other agency work is required; wherever the combination is attempted one or the other suffers the loss of the necessary direct care and watchfulness.

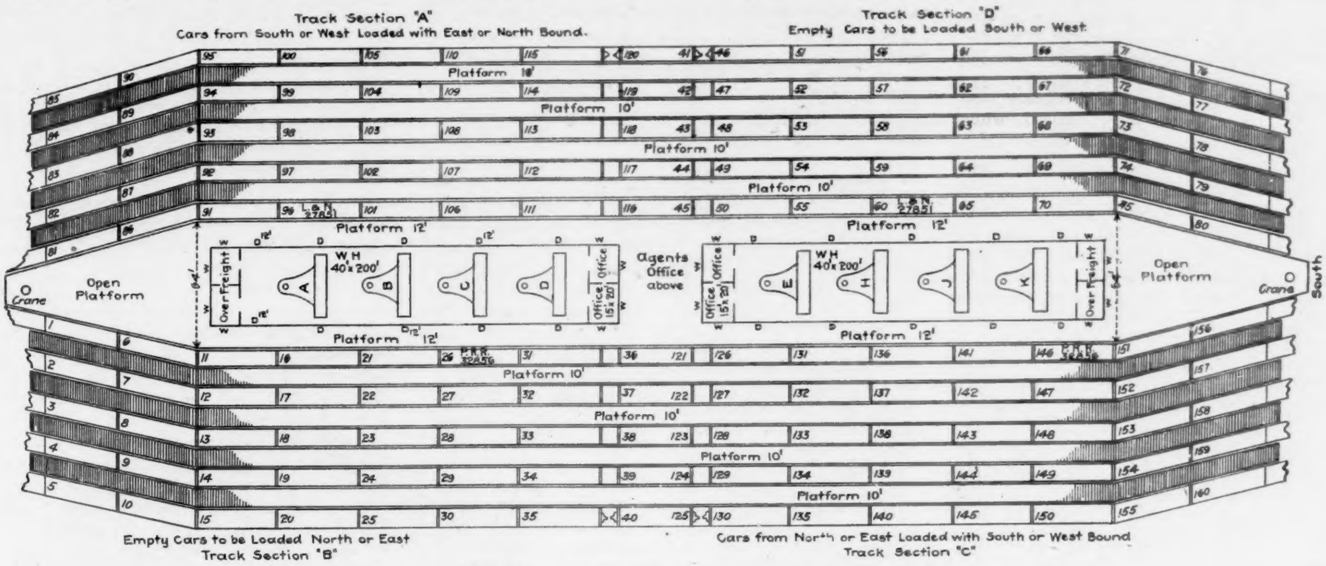
Seventh.—On local trains there should be consolidation of "pick-up" tonnage destined to or beyond a sub or general transfer into one special car, and on a minimum of five tons forwarded by first passing through train to the transfer. The common practice among local conductors opening the car was located; and in other ways he could load freight to the advantage of the conductor and the receiving agent. Again, with a knowledge of what cars some other point is loading, he could load to take advantage of their solid cars to points where he had not the tonnage to justify loading one.

Day work is preferable to night work, and at a large number of transfer points the former would, under proper conditions, accomplish all that would be necessary. Night work is objectionable for several reasons, among which are:

First—Absence of the responsible head.
Second—Additional cost.
Third—Less effective control of men.
Fourth—Increased opportunity for robbery.

Whether day or night or both, good switching service is absolutely essential to economical work. The plan submitted greatly reduces the work of a switching crew, and enables them to give satisfactory service with a minimum amount of labor and time.

should contain pigeon holes measuring 6 in. square by 12 in. deep, with a cross piece 2 in. by 6 in. at the top of each, numbered on left-hand corner to correspond with the track-space number occupied by the car in loading or unloading, leaving to the right of this number a black painted space 2 in. by 4 in. for chalking car numbers. Across the center of the case both horizontally and perpendicularly are double-sized openings for waybills. These openings bear the train numbers in the same manner that the space numbers are shown on the smaller pigeon holes; the former for depositing outward train waybills (after all record is taken and they are ready to move, with the cars), and in the latter the yardman is to place the train waybills ready for the distributing clerk to assort, by the foreman's track guide, into pigeon holes corresponding in number with the space locations of the cars.



Plan for a Freight Transfer House, with Numbered Track Spaces.

NOTE.—D = door; W = windows.

of loading freight picked up on the road into the most convenient car, brings about much trouble.

Eighth.—The superintendent of transfer should have daily reports from all principal stations and junctions, of L. C. L. tonnage passing through or originating at these points. Tissue copies of the auditor's daily forwarded report, so arranged in form as to provide for bulk-breaking points, would furnish ample information for keeping in close touch with the movement of this class of freight.

Ninth.—Skeleton maps should be provided, showing divisions, general and sub-transfers, junctions and their connections, with all stations shown on the warehouse side of the track; also a pamphlet giving the bulk breaking points for all L. C. L. cars loaded at transfers and principal stations. The lack of territorial information among those directly responsible for the physical handling of L. C. L. tonnage, is the prime cause of many costly blunders in loading. A clerk would not block the wrong door, if he knew on what side of the track the station first

Records are indispensable. I therefore submit three forms that will, in my opinion, make a complete record, satisfactory for all practical purposes:

Form No. 1—Platform record. General foreman enters up his first record of the cars as shown in vertical letters, and second in slanted letters.

Form No. 2—Waybill record. Record clerk first enters waybills received on this form as shown in vertical letters. The second record as shown by slanted letters is made after the return of waybills by transfer clerks. After this record is taken the waybills are turned over to the distribution clerks to be assorted by transfer car numbers into a case with pigeon-holes corresponding in number with the number of the track space occupied by the car in loading, designated as "distribution case."

This "Distribution Case," 54 in. high by 126 in. long,

Form No. 3—Tonnage and bulk-breaking point. On completion of load for any car (notice to be given by foreman) the waybills are taken from pigeon-hole in distribution case, checked, points to break-bulk ascertained, and tonnage footed up and entered on this form; after which they are enclosed in envelopes, addressed and placed in proper train box.

These forms printed on loose sheets are preferable to books, for the reason that the necessary size would make handling of the books awkward. The sheets could be filed in day or week order, and in this shape obviate the necessity of interrupting the record clerk when tracing.

The following loading system would prove simple and effective:

Equip each car being loaded and each division floor sign with a small wooden or tin box, numbered to correspond with the track or floor space numbers, to contain 100 hard pressed waterproof paper chips 1¼ in. in diameter, bearing same number as the box. The latter to

Platform Record of Cars Handled at..................Transfer..........19.... Form No. 1.

Car Initials and Number / Unloading Clerk		Seal Record: Line Condition	Door Seal	Window Seal	Unloading Space No.	Arrival: Train Hour	Month Day	Hour Placed. Hour Unloaded.	Delay on Yard at Transfer	Junction Point Received from Reloaded to	Loading Space No.	Hour Placed Hour Loaded	Delay at Tfr. Total Sta. Delay	Forwarding: Train Hour	Month Day	Condition of Car	Loading Clerk Packer	Remarks
Penn R R. Jones	3 2 8 6 6	P.R.R. Broken	221 221	221 x	146	*71 6a	8 30	7a 11a	1 4	Alexandria *New York*	26	*12N* *4P*	*9* *10*	**72* *6P*	*8* *30*	*Door* *BO*	*Smith* *Jones*	
L & N Williams	2 7 8 5 1	L.& N Indis	117 117	x 117	96	*80 5a	8 30	7a 10a	2 3	Atlanta *Mobile*	60	*11a* *6P*	*11* *13*	**81* *7P*	*8* *30*	*OK*	*Wilson* *Peters*	

Record of Way Bills and Loading at..................Transfer..........19.... Form No. 2.

Way Bill No Date	Originating Point Junction Point Via	Destination Junct. Point Via	Consignee	Marks	No	Articles	Weight	Exceptions	Car Received in; Unloading Clerk		Car Loaded in Loading Clerk	
2277 8/25	New York Alexandria	New Orleans Atlanta	Williams Bros. Co.	W	15	Cases Dry Goods	1 5 1 0 0	*1 Case* *B/O*	P.R.R. Jones	3 2 8 6 6	*L & N.* *Brown*	*2 7 8 5 1*
2278 8/25	" "	Mobile Ala Atlanta	Brown & Peters	B 1/20	20	Rolls Oil Cloth	1 0 0 0 0	*OK*	"	" "	"	" "
1727 8/24	New Orleans Atlanta	New York Alexandria	Smith Jones & Co.	JAC 1/20	20	Bales C Cotton	1 0 0 0 0	*OK*	L.& N. *Williams*	2 7 8 5 1	*P. R. R.* *Watkins*	*3 2 8 6 6*
1742 8/24	" "	Boston Mass. Alexandria	Wilkinson Cotton Mills	WC B	20	Bales C Cotton	1 0 0 0 0	*Marks* *Indistinct*	"	" "	"	" "

Record of Cars Forwarded, Break-Bulk Points and Tonnage at..................Transfer..........19.... Form No. 3.

Car Initials and Number		Loading Space No	Total Tonnage	Car Break Bulk at	Junction Point Via	Contents	Way Bill Record Forwarded: No.	Train	Date	Way Bills Mailed to Agent at	Forwarding of Car: Train	Date	Hour	Conductor	Remarks
P. R. R.	3 2 8 6 6	26	2 0 0 0 0	New York	Alexandria	Cotton	2			With Car	*72	8/30	6 P/m	Palmer	
L. & N.	2 7 8 5 1	60	2 5 1 0 0	Mobile	Atlanta	Mdse.	2	36	8/30	Atlanta	*81	"	7 P/m	Watson	

Sample Freight-Transfer Records—Accompanying Paper by Mr. E. H. Lea.

NOTE.—Entries shown in vertical letters represent the Inbound Record; slanted letters, the Outbound.

be hung on car door frame protected from weather, and on the division swinging signs within easy reaching distance. Clerks to be provided with white stick chalk for entering space numbers on a 2 in. x 17 in. blackboard, attached to and forming a part of the upper cross brace on trucks, so that when truck handles are perpendicular the blackboard will be in position for easy entering of numbers. After truck is loaded, the clerk enters the space number on the blackboard and calls off to the truckman the number he has written, who repeats it; the truckman deposits the load where instructed and takes from one of the tin boxes at that point a chip, which should agree with the number he has on his truck blackboard. On return to clerk it is compared and if the numbers are alike the truckman has complied with his instructions; if not the error can at once be adjusted. The plan compels the clerk to come to the truck to chalk the space number on the blackboard, and in doing this he would be more likely to examine marks of packages and thus check the freight more correctly. There are no tickets to be written, or previous instructions to be remembered by the clerk and his whole attention can be given to his checking. If the numbers of track space locations of cars to principal stations remain permanent, the clerks will readily commit them to memory, and make very few errors in entering numbers on truck blackboards. The cost of keeping blackboards in order is small; boxes and chips cost about 75 cents a car.

The simplicity of this plan commends itself. A check clerk should not be expected to do much more than check his freight. Any additional work delays the movements of his truckmen, creates dissatisfaction among those paid by the ton, and the company pays for the lost time of those paid by the day.

The success of these general transfers depends on the station and yard facilities furnished and the competency of those in charge. They can be made dividend paying institutions if properly handled.

With satisfactory conditions there is no good reason why L. C. L. time should exceed C. L. time by more than 24 hours as a maximum and six hours as a minimum, provided reciprocal arrangements are made with direct foreign connections to load solid to general or sub-transfer points, and these cars are given the same movement as full loads between these points. It is not so much the loss of time at any one transfer point as the aggregate delay at so many unnecessary transfers. Our efforts should, therefore, be directed towards eliminating many of the present transfers. Even with the maximum delay (which would include both a sub and a general transfer handling) the L. C. L. time, as compared with our present movement of this traffic, would under the plan herein outlined, be so greatly improved as to warrant the expenditure of any reasonable amount in the inauguration of an "inter-line transfer system."

The New Whitechapel & Bow Railway (London).

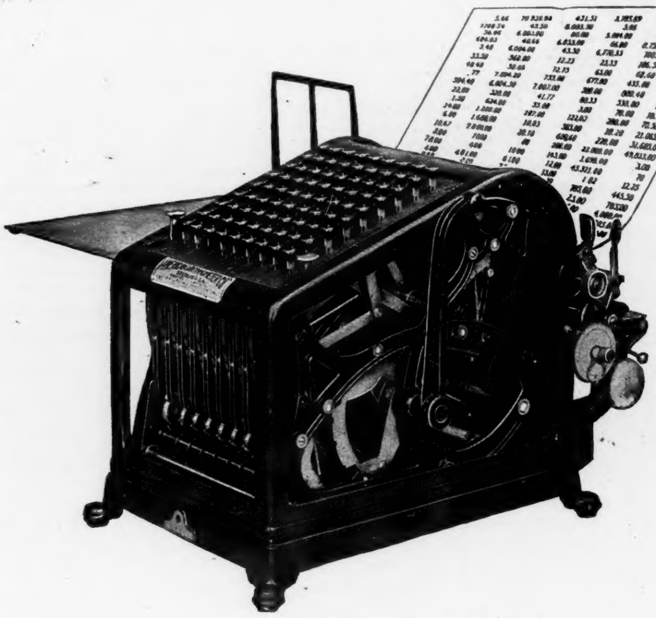
The Whitechapel & Bow Railway, built jointly by the London, Tilbury & Southend and the Metropolitan District, was formally opened for traffic June 1. It is about two and one-quarter miles long, runs below the surface for more than two-thirds of its length, and for nearly the whole of this distance the tunnel has been constructed by "cut and cover." The only important exception is the section of about 50 yards passing under the Regent's Canal, where the line is carried in two cast-iron tubes, each 18 ft. in diameter. This was done because there was not sufficient head-room under the canal for the brickwork tunnel to be put in. For the same reasons girders and "jack" arches carried on cement side walls were employed for a small section at the western end of the new line.

For practically the whole of its length underground the railroad runs beneath that great thoroughfare of eastern London which bears successively the names of Whitechapel road, Mile End road, and Bow road. This thoroughfare is so wide that a portion of it could be cut open without undue interference with the street traffic, and, the brick tunnel having been constructed in the cutting, the surface was then restored. At Bow Road Station the roadway was raised bodily 2 ft. to give headroom for the construction of the station, and dropped again when the underground work had been done. In taking up the roadway two or three miles of old sewers had to be cut out, and new ones in brick and concrete laid down. About two miles of gas and water pipes have also been reconstructed, some of the new pipes being 36 in. in diameter. Where the new railroad joins the main line of the Tilbury Company, an old bridge carrying the latter over Campbell road had to be removed and a new one erected to carry the junction lines without interfering with the traffic of the Tilbury Company. Close to this junction, moreover, seven arches had to be cut out of a brick viaduct carrying the Great Eastern Railway, and three girder bridges substituted to carry that line. While this work was in progress the Great Eastern Railway was temporarily diverted on a timber trestle bridge for a distance of 200 yds. The new line is to be worked at the outset by the District Company (old Underground.) A new direct system of communication will be provided right through London from west to east. Through trains will also probably be run between the West-end of London and Southend-on-Sea, while the city stations of the District Company will be utilized to relieve Fenchurch street from the pressure of the Tilbury's suburban traffic.

Even more important developments are expected from the starting of a goods and coal traffic over the whole length of the District system to and from the main trunk lines. In addition to its connections with the older lines from the north, the District has recently arranged a junction with the new Great Central line to London in the neighborhood of Harrow, which, in conjunction with the Whitechapel & Bow Railway, will provide the Great Central with a much-needed route to the London Docks and the East-end generally. It is further understood that the Great Western will make use of the new route for through goods traffic. When the District Railway is electrified arrangements are to be made for goods trains to be hauled over it at night by electric locomotives; and the Tilbury Company is seeking Parliamentary powers to electrify its line as far as East Ham, so as to fall in with the same scheme. Of course, in this event the Whitechapel & Bow Railway will have to be electrified also, and powers for this are already possessed.

The Burroughs Adding Machine.

A useful labor-saving device that has been developed within the past 10 years is the Burroughs adding machine, largely used in the accounting and auditing departments of railroads, banks and general business houses. The machine is a very ingenious piece of mechanism, actually performing some of the operations of the human mind. It adds figures and lists them with the greatest rapidity, enabling work of this kind to be done some five times faster than the most expert accountant can do it. By its use 300 items can easily be listed and added in a single hour.



Burroughs Adding Machine.

In using the machine the keys are pressed according to the values or amounts to be added and the handle is moved. The machine prints the various amounts successively in parallel columns on a wide sheet of paper, or on a long narrow paper strip, as may be preferred. The items, whether there be 10 or 10,000, are instantly footed whenever desired by simply pressing the "total" key and moving the lever. The machine does all the hard part, the drudgery, of accounting work, saving time, work and worry. It gives one clerk the efficiency of two or three, increasing his value and thereby decreasing his cost. It automatically does the detail work, enabling him to give his attention to the more important matters.

The Burroughs machine has been on the market 10 years, and the machines sold during the early days of the company are in use to-day and operating as well as when they were first made. It is built throughout of the finest polished steel, in an excellently equipped factory, by expert mechanics, and is made to last a business lifetime, the utmost care being exercised in its construction. Its durability and accuracy have already been tested by years of service. The machine is named after its inventor and is at present in use in some 10,000 accounting and auditing departments. It is manufactured by the American Arithmometer Co., St. Louis, Mo.

TECHNICAL.

Manufacturing and Business.

J. T. Rose, Contracting Manager of the Cotton State Bridge Co., Atlanta, Ga., tells us that application for incorporation has been made for this company, with a capital stock of $10,000, with the privilege of increasing to $200,000 at any time. The company will do a general manufacturing, contracting and engineering business, and for the present it is proposed to give special attention to highway bridges.

The Philadelphia Pneumatic Tool Co. is now working night and day in its new shops at Twenty-first street and Allegheny avenue. On account of recent improvements to the Keller pneumatic hammers, the working capacity of the chipping and rivetting hammers is increased at least 25 per cent., and the vibration is reduced very materially. The company has recently taken large orders from the Southern Pacific Co., the Newport News Shipbuilding & Dry Dock Co., the Pennsylvania R. R., the Lackawanna Steel Co., and others.

Iron and Steel.

F. H. Clergue is reported as saying that the steel plant at the "Soo" is now in operation and turning out a large quantity of rails.

During the month of May the output of the Tennessee Coal, Iron & Railroad Co.'s steel plant at Ensley, Ala., exceeded 15,000 tons and the shipments reached 13,500 tons.

The New Jersey Engineering & Supply Co., with office in Passaic, has recently been incorporated with $50,000 capital, to deal in engineers and railroad supplies.

According to statistics published by *The Iron Age* in its issue of June 12, the capacity of coke furnaces in operation on the first of the month was only 337,492 tons, as compared with 345,627 tons on May 1.

The old double-track iron bridge of the Pennsylvania across the Susquehanna River at Rockville, Pa., has been sold. It has been in use since 1874 and has 23 spans of 160 ft. each, a total length of about 3,700 ft.

Arnold D. Reece, formerly manager of the blast furnaces at the Maryland Steel Company's Works at Sparrows Point, Md., has been appointed to a similar position at the Dowlais Iron & Steel Works, South Wales.

The New Steel & Iron Co. was incorporated in New Jersey last week, with $100,000 capital. The incorporators are: John B. Wood, Horatio C. Wood and Arthur M. Wood, all of whom give their address as Camden, N. J.

At the annual meeting of the Illinois Steel Co., in Chicago, on June 11, the following officers were elected: President, E. J. Buffington; First Vice-President, T. W. Robinson; Second Vice-President, F. H. Foote; Secretary and Treasurer, T. J. Hyman.

The New Process Steel Co., recently formed, will hold a meeting in Homestead, Pa., this week, to increase the capital stock from $100,000 to $3,000,000. The increase will be used for building three steel foundries, one forge shop and a blast furnace and other structures.

Application is before the Dominion Government for the incorporation of the Canadian Iron & Foundry Co., to make car wheels and castings, with a capital stock of $150,000. The company at present is operating in the plant at Hamilton, recently bought from the Hamilton Wheel & Foundry Co. Robert J. Mercur is Manager.

Vibration on the Central London Railway.

It will be remembered that the vibration set up by the trains moving through the "Tuppenny tube" in London caused the organization of a Government Commission to look into the matter, and some time ago we published the essentials of the investigations and findings of this commission. The main point was that the motors should be spring hung, and that motor cars would probably be better than electric locomotives for this work. We are informed now that the experiments which had been made with self-contained trains, that is, motor cars without locomotives, had been satisfactory, and the Consulting Engineer of the London Central Railway has been ordered to provide the necessary cars for the whole line.

New Signals on the Pennsylvania.

The Pennsylvania Railroad is introducing an extensive new interlocking switch and signal system in connection with its extensive improvements in West Philadelphia. New plants will be needed from Broad street to Fifty-ninth street, near Overbrook, and to the east end of the Mantua Y, on account of the revision of the tracks. The Twenty-first street tower has been moved about two blocks west, close to the Schuylkill River. The next tower will be located at Thirty-first street, an entirely new location. This will control the trains passing the new passenger station at Thirty-second and Market streets. Another tower planned is for the low grade tracks connecting the Philadelphia, Wilmington & Baltimore with Broad street. There will be towers at the eastern end of the tunnel leading to the New York Division, controlling trains on the Philadelphia Division of the main line and the main line of the New York Division; at the east and west ends of the Mantua Y, controlling trains passing between the New York and Philadelphia Divisions through the new tunnel recently made under the freight yards; at Fifty-second street, and at Fifty-ninth street, near Overbrook. In addition to

this work the automatic block system is being extended from Paoli westward to Downingtown, and from South street station to Wilmington. Automatic block signals will also be introduced on the Delaware River bridge line, from Frankford Junction to Camden.—*Columbia (Pa.) News.*

Interlocking.

The Railroad Commissioners of Iowa have just approved a new interlocking plant at Marshalltown, said to be the largest in the State. This plant has 65 levers and controls a crossing over the double-track of the Northwestern, two tracks of the Chicago Great Western and the single track of the Iowa Central, besides a number of switches in the yards of the Iowa Central and Chicago Great Western.

Pintsch Gas Lighting.

We printed last week a table showing the number of Pintsch gas equipments now in service in the world. From that table (page 450) it will be seen that more than half of the passenger rolling stock of the United States is equipped for gas lighting, and that the increase during the year had been 1,500, or 9 per cent., in the United States. It will be seen that all the passenger cars in the world so lighted number 112,000, and that the increase in the year had been 6,427. Since 1897 there have been constant and costly efforts in the direction of developing other methods of car lighting, but in that time the Pintsch equipments have increased by 8,800 cars, of which 8,300 have been in the United States alone. On the Continent the equipment had been pretty well settled before that time.

The Gold Car Heating & Lighting Company.

The Gold Car Heating & Lighting Co., which has just been incorporated under the laws of the State of New York, with a capital of $1,000,000, has bought outright the entire business of the Gold Car Heating Co., of New York, Chicago and London, and also the entire business of the Gold Street Car Heating Co. It will take possession on July 1 of the property of both of these companies, and, in addition to nearly one hundred patents owned by them, it has acquired a number of new and valuable patents covering electrical apparatus. The business of the Gold companies extends all over the world and just now the companies have a larger number of unfilled contracts on their books than ever before in the history of their business. The foreign business of the company is larger now than ever before, over 2,000 sets of car heating apparatus being under construction for shipment abroad within the next three months. Among the large electric heater contracts recently received is one from the Louisville Railway Co. for over 300 sets of car-heating apparatus, and orders from the Jersey Street Railways for about 100 equipments. A contract has recently been closed with the Metropolitan Street Railway of New York for electric heating apparatus which will be a departure from anything of this character heretofore undertaken. The Gold companies have equipped nearly 40,000 cars and locomotives on about 500 railroads.

There are no bonds on the new company and there is no preferred stock. The capital is represented by 10,000 shares of common stock of the par value of $100 each, fully paid and non-assessable, and the company has no other liabilities whatever. The net value of the property taken over by the new company is $1,090,000. Mr. Edward E. Gold, of New York city, has been elected President of the new company and made Chairman of the Executive Committee. All of the stockholders of the old companies are stockholders of the new company. The main office of the new company will be at Frankfort and Cliff streets, New York city.

Rome Locomotive & Machine Works.

At the annual meeting of the Rome Locomotive & Machine Works, on June 12, the following officers were elected: President, H. Monkhouse; Vice-President, H. D. Cooke; Secretary, W. L. B. Hamon, and Treasurer, Arthur T. White. A semi-annual dividend of 3½ per cent. was declared. Among other things transacted at the meeting it was decided to enlarge the works, thereby affording the company improved facilities and increasing its output. The Rome Locomotive & Machine Works are owned and operated by the Compressed Air Co.

THE SCRAP HEAP.

Notes.

The news comes from West Superior, Wis., that the Great Northern Railway refuses to accept from its connections any freight car not equipped with air-brakes, or unless it has at least a train pipe so that air-brakes can be connected through to cars behind.

The New York Central now has four trains daily which run from New York to Chicago in 24 hours, namely: 8:45 a.m., fast mail; 1 p.m., Chicago Limited; 4 p.m., Detroit and Chicago Special; 5:30 p.m., Lake Shore Limited. A condensed schedule of the 20-hour train is given in another column.

On the morning of June 10 the car ferry "St. Ignace" overturned and sank at her slip at Mackinaw City. The boat had been loaded with cars of ore on one side only. This is the second accident of the kind at the Soo within a month. Freight transfers had to be suspended and passengers were carried across the straits by the steamer "Algoma."

At an adjourned hearing to consider the subject of collecting statistics of ton-mileage and earnings of different commodities transported by railroads, the Interstate Commerce Commission listened to the remonstrances of a number of railroad accountants who said that the labor of compiling the required statistics would be excessive. According to the newspaper reports, the Pennsylvania Railroad claims that it could not produce the report which the Commission desires for less than $375,000 a year. The press despatches state, however, that the controller of the New York Central asserted that, with the Hollerith tabulating machine, in use in his office, the work could be done at a cost that would not be burdensome; therefore his road made no protest against the proposed order.

Traffic Notes.

The Interstate Commerce Commission, in an opinion by Commissioner Fifer, has announced its decision in the case of Shippers' Union of Phœnix, Ariz., against the Atchison, Topeka & Santa Fe and others. The Santa Fe and the Southern Pacific reach Los Angeles, Cal., a point to which rates from the east are affected by water competition. Phœnix is not on either of these through lines, but is connected therewith by two lateral lines, one on the north connecting with the Santa Fe at Ash Fork, and one on the south connecting with the Southern Pacific at Maricopa. On complaint that freight rates between New York and other eastern points and Phœnix are unjust in themselves and relatively as compared with rates to Los Angeles, the Commission holds that the evidence was insufficient to justify modification of long-standing through rates which also apply over other transcontinental lines throughout a great belt of territory and affect numerous localities and interests which have not been heard in this proceeding, and this being so the relief sought by the complainant is for the present denied, but the case is retained for further consideration pending the investigation and disposition of other cases involving the same general question.

A Long Strike Ended.

One of the longest strikes on record has just been amicably settled between the Allis-Chalmers Co., of Chicago, and its employees. By the terms of the agreement the men receive an increase in wages, have a shorter workday granted, and are to be paid time and a half for overtime. The strike has been in progress for over a year, having been begun May 30, 1901, and has been prosecuted with the utmost energy. The original wage demand was for a 12½ per cent. increase, and as the grant amounts to approximately 11 per cent. the employees consider that they got practically what they asked for. Something over 300 men were involved, including machinists, blacksmiths, iron-molders and pattern-makers.

Fast Trains in Europe.

There have been some recent accelerations on the London & North Western which give 11 new runs at 54 miles an hour and over. The fastest is from Litchfield to Euston, 116½ miles in 125 minutes, or a speed of 55.9 miles per hour. A new service is inaugurated between Birmingham and London, the 113 miles being run in 125 minutes, or a speed of 54.2 miles per hour.

Further details from the Northern of France show some fine speeds. The fastest start-to-stop run is from Arras to Douai, 15½ miles in 15 minutes, or a speed of 62 miles per hour. The longest and fastest start-to-stop run is from Paris to Arras, 120 miles, in 117 minutes, or a speed of 61.5 miles per hour. This is probably the longest start-to-stop run scheduled over 60 miles an hour. The timing of the morning trains from Aulnoye are 55, 56.6, 52.5, 58 and 56.5 miles per hour, start-to-stop. There are still other brilliant bursts of speed.

R. HOPE.

The Irrigation Bill.

The House of Representatives on June 13 passed the irrigation bill previously passed by the U. S. Senate, and on June 14 the Senate agreed to some amendments made by the House, which finally passed the bill. The bill, as passed, creates a reclamation fund from the sale of public lands in Arizona, California, Colorado, Idaho, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming, less the amount paid to local land officers and 5 per cent. due the State under existing law for educational purposes, the rest to be used for the construction and maintenance of irrigation works in the States and Territories named above. Any deficiency in allowances made to agricultural colleges caused by this disposition of public lands is to be paid them from the Treasury, and the Secretary of the Interior is authorized to examine, survey and build the irrigation works, using the reclamation fund for that purpose and to report the cost to Congress at each session. "No right to the use of water for land in private ownership shall be sold for a tract exceeding 160 acres to any one land owner and no such right shall permanently attach until all payments therefor are made and no such sale shall be made to any land owner unless he is a bona fide resident on such land or occupant thereof residing in the neighborhood of said land." State control over waters of non-navigable streams such as are used in irrigation is required.

The Piraeus-Larissa Railroad.

Consul F. W. Jackson writes from Patras under date of April 2 that the general supervision of building this proposed line in Greece has been given to the Batignol Construction Co., of Paris.

The Steel Corporation Injunction.

On Monday of this week Vice-Chancellor Emery, of the State of New Jersey, gave a decision in equity granting an injunction against retiring the preferred stock of the United States Steel Corporation. The decision is, however, subject to appeal. In the opinion of the Court the Steel Corporation had no authority, prior to the act of March 23, 1902, to carry out a plan of this nature, because it is a plan for the preferential distribution of capital, and not a plan for an equal ratable distribution among all the preferred stockholders. The distribution of the capital released is solely among those who consent to take bonds and is clearly preferential. Before the passage of the act referred to, expressly authorizing the retirement of the stock of any holder by redeeming the same out of bonds, no such preferential right existed, but in the opinion of the Court this act is unconstitutional. Therefore, the corporation can derive no authority from it, and is enjoined from the execution of the plan.

The Washington Union Station.

The House Committee on the District of Columbia gave a hearing, June 12, on the bill providing for a union railroad station in Washington. John P. Green, First Vice-President of the Pennsylvania, and George E. Hamilton, attorney for the Baltimore & Ohio, were both heard. Mr. Green said the Pennsylvania had for many years been considering the question of providing better terminal facilities in the city. While the railroads had no initiative interest in the pending bill, they were satisfied with it, although it would increase the cost of their terminal facilities from the present cost of 40 cents a car to $1.20 a car. Mr. Green said the present plan would cost the roads $3,500,000 more than the plan provided for by the bill which became a law last year. He said that for the Pennsylvania alone the proposed improvement would cost $8,000,000. The roads had been satisfied to go ahead under the law of last year, but they were willing to incur the increased expenditure provided for by the pending bill in order to get a union station and provide the city with a magnificent building. G. E. Hamilton, speaking for the Baltimore & Ohio, said that company at first preferred the bill of last year, which provided for separate stations, but it has now reached the conclusion that the plan for a union station is right and ought to be carried out. He said that the additional cost to the Baltimore & Ohio under the pending bill, as compared with the one that passed last year, would be $300,000.

LOCOMOTIVE BUILDING.

The Bush Co., Ltd., is having one locomotive built at the Baldwin Works.

The Iowa & St. Louis has ordered two consolidation locomotives from the Baldwin Locomotive Works.

The San Pedro, Los Angeles & Salt Lake is having two locomotives built at the Schenectady Works of the American Locomotive Co.

The St. Louis, Kansas City & Colorado is having four locomotives built at the Baldwin Locomotive Co., and 10 at the Cooke Works of the American Locomotive Co.

The Terre Haute & Indianapolis order for four engines building at the Schenectady Works of the American Locomotive Co., reported in our issue of June 6, calls for simple engines of the Atlantic type; total weight, 160,000 lbs.; weight on drivers, 92,000 lbs.; cylinders, 20½ x 26 in.; 78-in. drivers; wide fire-boxes, with a working steam pressure of 200 lbs.; number of tubes, 338, with outside diameter of 2 in.; fire-box of carbon steel, 100 in. long and 63½ in. wide; tank capacity for water, 7,000 gal.; coal capacity, 20,000 lbs. The special equipment includes Westinghouse American air-brakes, Cambridge steel axles, National hollow brake-beams, cast-iron brake-shoes, Tower couplers, Sellers injectors, United States metallic piston and valve rod packing, Coale safety valve, Leach sanding devices, Latrobe driving wheel tires and McKee-Fuller truck-and tender-wheel tires.

The Wheeling & Lake Erie has ordered 32 locomotives from the Baldwin Locomotive Works: Two simple four-wheel switch engines, four simple six-wheel switch engines, eight eight-wheel simple passenger engines and 20 two-cylinder compound consolidation engines. The two four-wheel switch engines will weigh 81,000 lbs. and have 17 x 24 in. cylinders, 48 in. drivers, straight boilers with a working steam pressure of 175 lbs., 186 charcoal iron tubes, outside diameter 2 in., length 11 ft. 1 in.; fire-box 65 x 34½ in. of carbon steel; tank capacity 3,000 gal. of water and five tons of coal. The six six-wheel switch engines will weigh 107,500 lbs. and have 18 x 24 in. cylinders, 51 in. drivers, straight boilers with a working steam pressure of 180 lbs., 193 charcoal iron tubes, outside diameter 2 in., length 13 ft. 3 in.; fire-box 65 x 34½ in. of carbon steel; tank capacity 3,500 gal. of water and 5½ tons of coal. The eight eight-wheel passenger engines will weigh 134,000 lbs. with 90,000 lbs. on the drivers, and have 19 x 26 in. cylinders, 72 in. drivers, extended wagon top boilers with a working steam pressure of 200 lbs., 310 charcoal iron tubes, outside diameter 2 in., length 12 ft. 5 in.; fire-box 108 x 40 in. of carbon steel, tank capacity 6,000 gal. of water and eight tons of coal. The 20 consolidation engines will weigh 185,000 lbs. with 163,000 lbs. on the drivers, and have 23 and 35 x 32 in. cylinders and 57 in. drivers, extended wagon top boilers with a working steam pressure of 200 lbs., 326 charcoal tubes, outside diameter 2¼ in., length 14 ft. 6 in.; fire-box 108 x 71½ in. of carbon steel; tank capacity 6,000 gal. of water and 10 tons of coal. The special equipment for all includes Westinghouse air-brakes, Sterlingworth brake-beams, Tower couplers, Wheeling & Lake Erie standard headlights, Ohio injectors, Paxton-Mitchell piston and valve rod packings, Coale safety valves, Leach sanding devices, Nathan triple sight-feed lubricators, Latrobe driving wheel tires, standard steel truck wheels, Griffin tender wheels for consolidation engines, all bearings of Damascus nickle bronze, Richardson balanced valves, Alexander track replacers and Keasby Mattison lagging.

CAR BUILDING.

The Maine Central is having 50 freights built at the Laconia Car Works.

The El Paso & Southwestern is having 50 freights built by Haskell & Barker.

The Pittsburgh Coal Co. has ordered 100 coal cars from the American Car & Foundry Co.

The American Car & Foundry Co. has miscellaneous orders for 20 box and 20 logging cars.

The Missouri Pacific has ordered 1,500 box and 500 coal cars from the American Car & Foundry Co.

The St. Louis & San Francisco has ordered 10 automatic dump cars from the American Car & Foundry Co.

The Iowa & St. Louis has ordered 2,000 40-ton coal cars from the American Car & Foundry Co., instead of 500, as reported in our issue of June 13.

The Mexican Central order for 50 freight cars, reported in our issue of June 6, should be credited to the Mt. Vernon Car Co., and not to the American Car & Foundry Co.

The Chesapeake & Ohio specifications for 1,000 cars, reported in our issue of June 13, should read Corning brake-shoes used in connection with Pressed Steel brake-beams.

Kelley Bros., Snowshoe, Pa., have bought from F. M. Hicks 35 hopper bottom gondolas, rebuilt by the Hicks Locomotive & Car Works. The Hicks Locomotive & Car Works report four other small orders besides that of Kelley Bros.

The Chicago, Kalamazoo & Saginaw has ordered 20 box cars of 60,000 lbs. capacity from the American Car & Foundry Co. for September delivery. These cars will be 36 ft. long, 8 ft. 6 in. wide and 8 ft. 3 in. high, inside measurements.

The Tennessee Central has ordered from the American Car & Foundry Co. 150 gondolas, 100 flat cars, 50 box cars and five cabooses for November delivery. These cars will be 40 ft. long, with American Steel Foundry Company's steel body bolsters.

The Norfolk & Western order for 25 coaches with the Harlan & Hollingsworth Co., reported in our issue of June 6, are for September and October delivery. They will be 53 ft. long over end s...s. The special equipment includes steel axles, Westinghouse brakes, Gold heating system, Pintsch light, Edwards wide vestibule platforms, French springs, and Norfolk & Western standard trucks and wide vestibules. The wheels will be cast-iron.

The Rodger Ballast Car Co. has received an order from the St. Louis & San Francisco for 98 convertible center and side dump ballast coal and flat bottom gondola cars; also two standard double plow distributing cars. The convertible features of this car practically gives three standard cars in one. The cars will be equipped with Common Sense bolsters, Westinghouse air-brakes, Sterlingworth brake-beams and Miner tandem draft rigging built on M. C. B. standards throughout.

The Iowa Central order for cars to be built at the Pullman Works, reported in our issue of May 30, calls for two chair cars and two coaches, with wide vestibule. Length, 60 ft. over sills; width, 10 ft.; height, 14 ft. 7½ in. The special equipment includes Streeter steel-back brake-shoes, Westinghouse brakes, with slack adjuster; Fulton brasses, National couplers, Gold heating system, McCord journal boxes and journal box lids, and Gould steel Z bar platforms. The wheels are Boies 36-in. steel-tired.

The International & Great Northern order with the American Car & Foundry Co. calls for three dining cars, November delivery. The cars will be 60 ft. long, 9 ft. wide and of standard height. The special equipment includes National-Hollow brake-beams, Westinghouse air-brakes, Phosphor bronze brasses, National couplers, Burrowes curtain fixtures, Westinghouse friction draft rigging, International & Great Northern standard dust guards, Safety heating system, International & Great Northern standard paint, A. French Spring Company's springs, and International & Great Northern standard trucks.

The Cincinnati, New Orleans & Texas Pacific order with the American Car & Foundry Co. reported in our issues of May 16 and 30 and June 13 has been closed and calls for 825 miscellaneous cars, 200 of which will be box cars of 60,000 lbs. capacity, the balance being coal and flat. The box cars will be 36 ft. long, 8 ft. 6 in. wide and 8 ft. high. The special equipment includes Buckeye couplers, Sterlingworth brake-beams, Westinghouse air-brakes, Hein couplers, Cincinnati, New Orleans & Texas Pacific Railway Company's standard door fastenings, Jones doors, Thornburgh draft rigging, Winslow roofs, French springs and arch bar trucks.

The Chicago & Western Indiana has ordered 250 gondola cars of 80,000 lbs. capacity from the Haskell & Barker Co. These cars will be equipped with Westinghouse trucks, Detroit couplers, side dump doors and end gates. The order for 50 box cars, reported in our issue of June 6, was given by the C. & W. I. to the Pullman Co., for use on the Belt Ry. of Chicago. These cars will be 60,000 lbs. capacity; length, 36 ft. 10½ in.; width, 9 ft. 2 in.; height, 8 ft., inside measurement, to be built of wood with wood underframes. Special equipment includes M. C. B. axles, Simplex bolsters, National hollow brake-beams, Westinghouse brakes, M. C. B. brasses, Gould couplers, Dunham doors, Gould draft rigging, Chicago roofs, old style, and standard arch bar trucks.

The Erie has ordered 10 express cars from the American Car & Foundry Co., to be 60 ft. long, inside measurement, and 60 ft. 8¾ in. over end sills; width, 9 ft. 1 in., inside measurement; 10 ft. 1½ in. over eaves; height, 14 ft. 2⅞ in. from rail to top of car, to be built of wood with wood underframes. Special equipment includes 5 x 9 M. C. B. standard steel Erie axles, double wrought-iron body bolsters, National hollow brake-beams, Westinghouse schedule "P" brakes, 5 x 9 M. C. B. standard Erie brasses, Janney Buhoup couplers, two 5-ft. sliding doors on each side of car, Standard Coupler Co. draft rigging, Gold heating system, cast-iron journal boxes with pressed steel Morris lids, Pintsch and Hicks & Smith light, helical triplet equalizer springs and double elliptic bolster springs, and Erie standard six-wheel trucks.

The Chesapeake & Ohio order with the American Car & Foundry Co. for 100 coke and 100 flat cars, reported in our issue of June 6, has been increased to 200 coke and 200 flat cars, to be built at the Huntington Works. These cars are for September and October, 1902, delivery. The coke cars will be 60,000 lbs. capacity; length, 36 ft.; width, 8 ft. 1½ in.; height, 7 ft. 4¾ in., inside measurement, to be built of wood with wood underframes. The flat cars will be of 80,000 lbs. capacity; length, 38 ft. 5¼ in.; width, 8 ft. 9 in., to be built of wood with wood underframes. The special equipment for both classes of cars includes Diamond brake-beams, Corning brake-shoes, Westinghouse air-brakes, Atlantic Brass Company's brasses, Tower couplers, Miner draft rigging and Railway Steel Spring Company's springs. The flat cars will have Pressed Steel Car Company's bolsters, and the coke cars C. & O. arch bar bolsters.

The St. Louis & San Francisco order with the American Car & Foundry Co., reported in our issue of June 13, includes besides the box cars mentioned, three combination baggage and mail and six postal cars. The baggage and mail cars will weigh 89,000 lbs.; length, 66 ft.; width, 9 ft. 10 in.; height, 6 ft. 4½ in. The special equipment includes M. C. B. standard axles, Lawler's brake-beams, quick-action automatic air-brakes, M. C. B. standard brasses, Janney couplers, Lawler standard door fastenings, New York Safety Car Heating & Lighting Company's heating system, and Frisco standard six-wheel trucks. These cars have no platforms but a vestibule chafing plate is attached, without diaphragms. The postal cars will weigh 98,300 lbs. and be 60 ft. 8½ in. long over end sills; width, 9 ft. 10 in. over side sills; height, 6 ft. 6 in. from top of sill to bottom of plate. Special equipment includes M. C. B. lead lined brasses, Janney couplers, American Car & Foundry Company's draft rigging, basswood and leather dust guards, stub end platforms, Detroit springs and six-wheel trucks.

The Illinois Central order reported in our last issue should read 800 box cars from the American Car & Foundry Co., and 200 from the Mt. Vernon Car Co., these cars to be of 80,000 lbs. capacity, for October delivery. Length, 36 ft.; width, 8 ft. 6 in.; height, 8 ft., inside measurements. The special equipment includes Simplex bolsters, Lappin brake-shoes, Westinghouse air-brakes, Hewitt Mfg. Co. brasses, Trojan couplers, Security doors, Gould draft rigging, Sherwin-Williams paint, Chicago roofs, Railway Steel Spring Company's springs, and Fox & Kindl trucks. Five hundred 60,000 lbs. fruit cars have also been ordered from the American Car & Foundry Co. for October delivery. These cars will be 36 ft. long, 8 ft. 6 in. wide and 8 ft. high, inside measurements. The special equipment includes Common Sense bolsters, Lappin brake-shoes, Westinghouse air-brakes, Hewitt Mfg. Co. brasses, Buckeye couplers, Security doors, Gould draft rigging, Sherwin-Williams paint, Hutchins plastic roofs, Railway Steel Spring Company's springs and Kindl trucks.

BRIDGE BUILDING.

ALABAMA.—On June 10 a bill was introduced in the U. S. Senate authorizing the Pensacola, Alabama & Tennessee Railway to build a bridge across Alabama River, in Wilcox County, Alabama.

ALBION, IND.—Bids are wanted July 8 by Thomas A. Huston, County Auditor, for some stone and steel bridges, ranging from 22 to 80 ft.; also for seven jobs of stone abutments.

ARKANSAS.—The U. S. Senate on June 10 passed the bill authorizing the Newport Bridge, Belt & Terminal Ry. to build a bridge across White River, in Arkansas. (June 6, p. 420.)

ARTEMUS, KY.—Bids will be wanted in a short time for an iron and stone bridge over Cumberland River, 375 ft. long, at an estimated cost of $15,000. Address J. H. Davis, Barboursville, Ky.

BINGHAMTON, N. Y.—The Town Board of Union has decided to span Hooper Creek with a new steel bridge, according to plans made by State Engineer Bond.

BOSTON, MASS.—William Jackson, City Engineer, writes us that the plans for the steel superstructure of the Atlantic avenue bridge are not yet prepared. The Broadway bridge plans are partly done and part of the work will probably be advertised within a short time. (June 6, p. 420.)

BRAINERD, MINN.—The House of Representatives on June 10 passed the bill authorizing the Commissioners of Crow Wing County, Minn., to build a bridge across the Mississippi River between Pine River and Dean Brook. (April 18, p. 293.)

BUCKINGHAM, VA.—The Chesapeake & Ohio, according to report, has offered to join with the county in building a $9,000 bridge over James River at Wingina.

BUFFALO, N. Y.—See Erie R. R. under "Railroad Construction."

CALDWELL, IDAHO.—We are told bids are wanted Sept. 9 by Edgar Meek, Clerk, for a combination bridge 352 ft. long.

CIDALIA, LA.—The Police Jury of Concordia Parish wants bids July 14 for building three bridges. James P. Fagan, President.

CLAIRTON, PA.—The Elizabeth & Clairton Bridge Co., of Pittsburgh, was incorporated in Pennsylvania June 9.

COLENDALE, WASH.—Bids are wanted July 10, according to report, for a bridge over Swale Creek. E. O. Spoon, County Auditor.

DANVILLE, ILL.—It is said that Professor M. S. Ketchum, of the University of Illinois, estimates that a bridge over the north fork of Vermillion River will cost about $140,000.

DAYTON, OHIO.—Bonds for $140,000 will be sold on July 7 to pay for the proposed bridge over Great Miami River at Main street. Bids will probably be wanted in the near future for construction.

DESERONTO, ONT.—An officer of the Bay of Quinte Ry. tells us that the bridge proposed over the Bay of Quinte will be a truss structure 2,100 ft. long, for which the plans are not yet made.

ENGLEWOOD, N. J.—The Bergen County Board of Freeholders has let a contract to F. R. Long & Co., of Hackensack, for the Clifton avenue bridge over the Passaic, the price being $38,900.

ERIE, PA.—It is said that the "Nickel Plate" has submitted plans to the city authorities for a new bridge over State street, replacing the present structure.

GUTHRIE, OKLA. T.—The Governor has forwarded requisitions to the Interior Department for the following bridges: Over Washita near Cobb, $4,600; another bridge over Washita costing $3,490. Another bridge is proposed over Cache at a cost of about $2,100. A bridge over East Cache Creek is to cost $3,500; a bridge over West Cache Creek, $3,470. The Department has already authorized three bridges in Kiowa County, each costing less than $1,000.

HAMMOND, IND.—A bill has been introduced in the United States House of Representatives authorizing the New York, Chicago & St. Louis and the Erie Railroads to build a drawbridge across the Calumet River near Hammond, about 500 ft. east of the Illinois-Indiana State line, and 100 ft. east of the present bridge. The bill also permits the Chicago & State Line road to build a bridge over the river at a point near Cummings as a substitute for the two bridges now there.

HARTFORD, CONN.—Members of the Connecticut River Bridge & Highway District Commission are reported as saying that they have given up the idea of building a stone bridge between Hartford and East Hartford, and that plans are already being reconsidered for a steel structure.

HARTSELLS, ALA.—We are told that bids will be wanted by Oct. 1 by the County Commissioners at Decatur, for a steel bridge 160 ft. long over Cedar Creek. Wm. E. Skeggs, Judge of Probate.

HARVEY, IOWA.—A highway bridge will be built over the Des Moines this season. Address R. A. Pellmar, County Supervisor.

HAYMARKET, VA.—Bids are wanted July 30 by the County Clerk at Manassas for a steel bridge over North Fork at Haymarket.

HERKIMER, N. Y.—The State Railroad Commissioners have determined that the Utica & Mohawk Valley Ry. shall cross the tracks of the New York Central by an overhead bridge.

HIGH SHOALS, GA.—Bids are wanted July 1 by C. M. Harrison, County Clerk, Monroe, Ga., for a steel bridge 345 ft. long over Appalachee River. He will be glad to hear from bridge builders in the meantime.

IOWA.—The House of Representatives on June 10 passed the bill authorizing a pontoon bridge across the Missouri river, between Cass County, Neb., and Mills County, Iowa. (May 30, p. 402.)

ITHACA, N. Y.—It is said bids will be wanted soon for the steel bridge to be built over Six-mile Creek at Albany street. Estimated cost, $3,000.

JERSEY CITY, N. J.—The Pennsylvania R. R. will build a bridge over Erie street between Fifth and Sixth streets. The company is widening the freight road along Sixth street, and it is necessary to build extra trestles at each street crossing.

KINGSTON, N. C.—A bill was introduced in the House of Representatives, on June 11, authorizing the Kingston & Jacksonville R. R. to build a bridge across Neuse River, at or near Kingston, N. C.

LANCASTER, PA.—We are told that contracts for the bridge work, for which bids were opened May 16, have not been let, and there is now no likelihood of any new bridges being built in Lancaster County this year. A. B. Hassler, County Comptroller. (April 25, p. 313.)

LOS ANGELES, CAL.—The contract for the through truss bridge over Los Angeles River for the Southern Pacific Co. is let to the American Bridge Co. It is to consist of three spans of 115 ft. each.

MCKEESPORT, PA.—It is understood that the Pittsburgh, McKeesport & Connellsville Ry. will build a viaduct over the Baltimore & Ohio and the Pittsburgh & Lake Erie tracks at Riverton street.

MADISON, VA.—We are told that a bridge 160 ft. long will be built over Robinson River by Madison County, but it is not stated when bids will be wanted.

MENOMONEE, WIS.—A steel bridge is proposed over Red Cedar River at Sand Creek at a cost of about $3,500. No date is set on which to get bids. W. E. VanBrunt, at Sand Creek, can give information.

MONROE, WIS.—We are told that bids will probably be wanted in November by Philip Allen at Browntown, for a steel bridge in Cadiz Township, at a cost of about $6,000.

MONTAGUE, TEXAS.—Bids will be wanted soon by J. M. Singleton for a steel bridge about 100 ft. long over Farmers Creek near Spanish Fort.

NASHVILLE, TENN.—Gustav Bottinger, Chief Engineer of the Tennessee Construction Co., building the extension of the Tennessee Central, writes us that he has just received bids for a steel bridge 650 ft. long over Cumberland River one mile west of Nashville. It is to consist of two pin-connected through trusses of 165 ft., and 185 ft. from center to center of pins, and one pin-connected through draw span 300 ft. from center to center of pins. The total cost will be $125,000.

OMER, MICH.—A steel bridge is proposed in Turner Township. Address Wm. Price, Supervisor, Turner, Mich.

PHILLIPSBURG, N. J.—The special committee of the Board of Freeholders on building and repairs to county bridges has ordered bonds issued to the amount of $25,000 to be sold within the next five months to pay for necessary work.

PITTSBURGH, PA.—Viewers appointed to inquire into the necessity of building new bridges over certain streams, have reported to the Court of Quarter Sessions in favor of these bridges: Over Robinson's Run, Collier Township; over Deer Creek, Richland Township, and over Miller's Run, LaFayette Township.

RICHMOND, QUE.—Richmond has voted to build a new bridge over the St. Francis River, in accordance with a bill passed by the last meeting of the Legislature, and to cost about $14,400. Address E. F. Cleveland, Secretary.

ROCHESTER, N. H.—In regard to the report that an iron bridge will be built over Salmon Falls River, we are told that no such structure is proposed this year. (May 9, p. 352.)

ROCKY MOUNT, VA.—The County Commissioners are considering building steel bridges over several streams in Franklin County, but have not yet decided as to the cost.

ST. CHARLES, ILL.—A bridge will be built over Fox River, according to report, by the Elgin, Aurora & Southern Traction Co.

SANDY HILL, N. J.—The Commissioners of Washington and Saratoga Counties are considering building a new bridge over the Hudson River at a cost of about $36,000.

SAN JOSE, CAL.—The County Treasurer has been ordered to set aside $2,500 to pay for a bridge over Saratoga Creek at Longbridge.

SAVANNAH, MO.—Contracts will be let at the court house July 7, for 12 bridges of various sizes. J. E. Schnitzius, Road and Bridge Commissioner.

SOUTH BEND, IND.—Contracts for bridges are soon to be let by the Indiana Ry. Alonzo J. Hammond, City Engineer, is the Chief Engineer for the company. (See Railroad Construction column.)

SPRINGFIELD, ILL.—The Chicago & Alton, according to report, has had surveys made at Eighth street and Eastman avenue for a viaduct and it is said bids will probably be wanted soon.

TENNESSEE.—The House of Representatives on June 10 passed the bill authorizing the Harriman Southern R. R. to build a bridge across the Tennessee River, in Tennessee. (May 9, p. 352.)

The House of Representatives also passed on June 10 the bill authorizing a bridge across the Cumberland River, in Davidson County, Tennessee, by the Nashville Terminal Co. (April 4, p. 256.)

TORONTO, ONT.—York County Council will build a steel bridge over the Maskinonge River.

WAKEFIELD, QUE.—The town council is authorized to raise a loan of $3,000 for an iron bridge at the head of Peche Rapids, to be 220 ft. long, on concrete foundation, to cost $10,000.

WASHINGTON, D. C.—A bill has been introduced in the House of Representatives providing for a bridge across the east branch of the Potomac River from the foot of Capitol street to Congress Heights. The work is to be done by the District Commissioners at a cost not to exceed $500,000.

WESTMORELAND, KAN.—Bids are wanted July 10 at the office of the County Clerk, A. P. Scritchfield, for building a steel bridge.

WINCHESTER, IND.—Bids are wanted June 21 by the Board of County Commissioners for eight bridges of various sizes. Geo. Warner, Chairman.

WINNIPEG, MAN.—The Canadian Pacific is calling for tenders for bridges at St. James and Headingley.

Other Structures.

ATLANTA, GA.—The St. Louis Car Wheel Co., of St. Louis, Mo., will build a wheel foundry at Atlanta, the foundry building being 230 ft. long and 95 ft. wide, with wings for the engine and boiler house. The cost of the plant is estimated at $75,000.

CHESTER, PA.—The Howery Mfg. Co., capitalized at $200,000, it is said, will build an iron works in this city. J. D. Howery is President, and Wm. H. Berry is Treasurer. The main building will be 544 ft. long and 106 ft. wide.

FORT WORTH, TEXAS.—The International & Great Northern is reported to have bought 60 acres of ground as a site for its proposed shops.

HAMILTON, OHIO.—The Cincinnati, Hamilton & Dayton, it is said, will build a new freight depot in Hamilton this summer.

INDIANAPOLIS, IND.—A local report says contracts are being let by the Superintendent of Motive Power of the "Big Four" for improvements at a number of roundhouses. Plans are being made to increase the size of the Brightwood roundhouse. The contract for enlarging the roundhouse at Ivorydale is let to L. B. Milliken, of Indianapolis, and the improvements at Delaware and Springfield has been let to T. E. Hill, of Chicago.

ONEIDA, N. Y.—The M. L. Ryder Building Co. of Albany have the contract for the new New York Central station at Oneida, to cost $30,000. The building will be 114 ft. long, 43 ft. wide and one-story high. Besides the depot, other improvements are to be made at Oneida.

PITTSBURGH, PA.—The River & Railroad Terminal Co., and the Keystone Commercial Co., according to local reports, propose to spend several million dollars in building warehouses along the Monongahela River extending back to Carson street. It is said plans are well under way and that contracts for some of the work will be let within a few days. Those interested are: James A. Henderson, President of the Pittsburgh & Cincinnati Packet Line; W. C. Johnston, J. J. Vandergrift, Geo. M. Laughlin, of Jones & Laughlins, Ltd., and others.

SALAMANCA, N. Y.—According to local reports, the Erie R. R. will begin work in the near future on the proposed new station.

STOCKTON, CAL.—In regard to the report that J. Hammond & Co., San Francisco, intend building an extra car works in this city, we are told that there is no truth in the report. The company has no intention of removing its works from San Francisco.

SYRACUSE, N. Y.—A union central passenger station on the North Side, the elimination of the Central tracks south of the Erie Canal, and possibly a freight yard on the North Side, are among the improvements contemplated by the New York Central in this city. Officers of the road have recently been consulting with Mayor Jacob Amos in regard to the passenger station.

The Hyle Brothers Steel Co. has increased its capital to $3,000,000 to make enlargements.

UTICA, N. Y.—The Utica & Mohawk Valley Ry. has let a contract to the Buffalo Structural Steel Co. for its new shops in Utica. The masonry work will be done by Griffith & Pierce, and the carpenter work by John Ulrich, both of Utica. The building is to be built with brick walls and iron trusses, and with slate roof. It will be 54 ft. wide and 225 ft. long. There are to be two tracks running through the building, one of which will extend half way into the paint shop.

WASHINGTON, PA.—A new passenger station is reported proposed by the Pennsylvania in this city.

YOUNGSTOWN, OHIO.—Contracts have been let for the brick and steel to be used in the new plant of the Republic Iron & Steel Co., of Youngstown, which, including machinery equipment, will cost $1,500,000. S. V. Huber, of Pittsburgh, is the Engineer. Contracts have also been let for a series of continuous furnaces to the Morgan Engineering Co., of Worcester, Mass., and Jones & Laughlins, Ltd., for shafting and pulleys.

PERSONAL.

—The new Superintendent of Terminals of the St. Louis, Keokuk & Northwestern, Mr. F. H. Ustick, was born in the State of Iowa in 1858. He entered the service of the Burlington Route in 1884, as a freight brakeman on the Hannibal & St. Joseph; was promoted to freight conductor in 1885, and remained in the service of this company until 1893, when he was transferred to the St. Louis, Keokuk & Northwestern (a division of the Burlington Route) as freight and passenger conductor, and three years later became general yardmaster. On June 1, this year, he was promoted to the position of Superintendent of Terminals at St. Louis, Mo.

—Mr. Alex. B. Todd, Division Master Mechanic of the Santa Fe Railroad at Winslow, was born in Cincinnati, Ohio, in 1860, and entered the Pennsylvania Railroad shops at Altoona as a special apprentice in 1876. He was Assistant Road Foreman of Engines until 1884, when on account of ill health he accepted the position of Division Master Mechanic of the Mexican National at Acamboro, Mexico. From there he went to Santa Barbara and remained until the fall of 1888, when he organized the A. B. Todd Foundry & Machine Company of Tacoma, and was its President and General Manager until 1893. From that time until 1898, Mr. Todd was engaged in general contract. In 1898 he became Master Mechanic, department of construction and repair at the Puget Sound Navy Yard, Washington, and discharged these duties up to the time of his recent appointment.

—The death of Mr. Gaston Meslier at Grand Rapids, Mich., on Sunday, June 8, has removed a figure well-known in passenger circles throughout the West and Southwest. He had filled many positions of prominence, having at one time been General Passenger and Ticket Agent of the Texas & Pacific. His railroad career was begun as a freight brakeman on the Springfield & Southwestern; he advanced in the service of that road, leaving it to become Southwestern Passenger Agent of the Wabash, St. Louis & Pacific. He later became Chief Clerk and then Assistant General Passenger Agent of the Missouri Pacific, and in October, 1888, he was appointed General Passenger and Ticket Agent of the Missouri, Kansas & Texas. In April, 1892, he accepted a similar position with the Texas & Pacific, remaining until April, 1897. He was then made Secretary of the Memphis Passenger Association and in 1901 he moved to Chicago. A short time ago he was appointed Passenger and Freight Agent of the Grand Rapids Electric R. R. system, and had just assumed the duties of that office at the time of his death.

—Mr. W. R. McKeen, Jr., who has been appointed to succeed Mr. S. Higgins as Superintendent of Motive Power and Machinery of the Union Pacific, is a young man who has risen rapidly in mechanical railroad service. He is a son of W. R. McKeen, former President of the Terre Haute & Indianapolis, and was born Oct. 4, 1869, being at this time 33 years old. He graduated from Rose Polytechnic Institute, Terre Haute, Ind., in 1889, having taken the mechanical engineering course. He supplemented this by a year at Johns Hopkins University, after which he spent a year in Berlin, Germany, taking a special electrical course. He entered railroad service as a special apprentice in the Columbus, Ohio, shops of the Pittsburgh, Cincinnati, Chicago & St. Louis, and at the expiration of a year and a half he was made General Foreman of the Vandalia shops at Terre Haute. While occupying this position he received the degree of Mechanical Engineer from Rose Polytechnic for a thesis upon the re-design of a locomotive. In December, 1898, he went to the Union Pacific as Master Mechanic at North Platte, Neb., and in May, 1901, was transferred to the Wyoming Division, with headquarters at Cheyenne. His present promotion is a recognition of unusual ability combined with an excellent preparation and training for the exacting duties as head of the mechanical department of a large railroad system.

—Major Ira A. Shaler was very seriously injured, fatally it is feared, by the fall of a fragment of rock in the rapid transit subway tunnel in New York City, last Tuesday. Major Shaler, Mr. William Barclay Parsons, Chief Engineer of the Rapid Transit Commission; Mr. George S. Rice, Deputy Chief Engineer, and Mr. C. E. Fraser, the contractor's engineer, were making an inspection of the tunnel when a fragment of rock fell from the roof, hitting Major Shaler on the head, the shoulders and one leg, causing flesh wounds and, it is believed, breaking the spine. He is now at a hospital and the surgeons fear that one or more of the cervical vertebrae is splintered and pressing on the spinal cord; at any rate, the lower part of the body and the legs are paralyzed. It does not seem likely now that Major Shaler will live, and it seems certain that if he does live he will be a helpless cripple, and doubtless he would much prefer to die. This is the culmination of a series of great misfortunes that have befallen this good engineer, honorable man and gallant gentleman. The first of these was the disastrous explosion in the tunnel a few months ago, wrecking property and killing a number of people. Major Shaler is now under indictment for manslaughter as a consequence of this explosion. Somewhat later serious slides took place in the tunnel, doing further damage to adjacent property. It is supposed that Major Shaler has been for some time working as an employee of the contractor, rather than as himself a sub-contractor. We have never heard any competent engineer blame Major Shaler for the disasters which have befallen him, and, in fact, we have never heard anybody speak ill of him. He is held in high esteem for his personal qualities as well as for his professional skill. He is about 40 years old, a native of New York and a graduate of Cornell University. He served in the Spanish-American war as a major in the First Regiment of Volunteer Engineers. He is a member of the American Society of Civil Engineers, the Lotus Club and the Barnard Club of New York.

—A little more than a month ago Mr. H. A. Gillis, General Superintendent of the Richmond Locomotive Works, was presented with a loving cup by the President and Directors of that Company. The occasion was the merging of the local company in the American Locomotive Company, and the officers of the old company wished to indicate their appreciation of the services of Mr. Gillis, who remains as General Superintendent of the works under the new control. The letter transmitting this testimonial is signed by Mr. Joseph Bryan, President of the Richmond Locomotive Company, and is as follows:

I send you to-day a loving cup presented to you by the President and Directors of the Richmond Locomotive Works in grateful testimony of your services well done as General Superintendent from 1897 to 1901. In addition to all that this testimonial imports, I wish to add a word which could not be engraved on the silver. You know the difficulties which surrounded you when you first came to the Richmond Locomotive Works in September 1897. You also know the vast improvement of its mechanical departments and the efficiency of its organization which, during your superintendency, it had gained when it passed into the hands of the American Locomotive Company in June, 1901. How much of this striking and acknowledged improvement was due to your own wisdom and energy I cannot fully express herein. I will say, however, that I do not know another man who better than you could have filled the place which fell to your lot. The work which you and your associates did made possible and achieved success which was obstructed by difficulties apparently insurmountable. It may be that we will never again work together, as we have done, but the memory of your labors and of your loyal support will be a refreshing recollection to my life's end.

ELECTIONS AND APPOINTMENTS.

Atchison, Topeka & Santa Fe.—F. W. Thomas has been appointed Engineer of Tests, with headquarters at Topeka, Kan.

Brooklyn Rapid Transit Co.—D. S. Smith has been appointed General Manager.

Burlington Route.—See Hannibal & St. Joseph.

Central Pacific (Southern Pacific).—The officers of this company are: President, E. H. Harriman; Vice-President, C. H. Tweed; Treasurer, N. T. Smith; Secretary, J. L. Willcutt, and Assistant Secretary, D. R. Gray.

Cincinnati, Richmond & Muncie.—A. L. Kuehn has been appointed Engineer of Maintenance of Way, with headquarters at Richmond, Ind.

Delaware & Hudson.—W. C. Ennis has been appointed Master Mechanic of the Pennsylvania Division, with headquarters at Carbondale, Pa., succeeding Robert Rennie, resigned, effective June 16.

Duluth & Iron Range.—H. Johnson has been elected Secretary, relieving C. P. Coffin to this extent.

Gulf, Colorado & Santa Fe.—J. S. Hershey has been appointed Assistant General Freight Agent, with headquarters at Galveston, Texas.

Hannibal & St. Joseph.—G. M. Hohl has been appointed Superintendent of Telegraph of this company and the St. Louis, Keokuk & Northwestern, the Kansas City, St. Joseph & Council Bluffs and the Chicago, Burlington & Kansas City, with headquarters at St. Joseph, Mo.

Louisville & Atlantic.—L. Wellisch has been appointed Master Mechanic, with headquarters at Richmond, Ky., succeeding S. A. O. Bullock, resigned.

Minnesota Transfer.—M. J. Dooley has been appointed Superintendent, with headquarters at St. Paul, Minn., succeeding T. F. Hastings, resigned.

New York Central & Hudson River.—William Smith has been appointed Assistant Master Mechanic of the Hudson, Harlem and Putnam Divisions, with headquarters at Mott Haven. During the illness of the Master Mechanic, W. J. McQueen, the Assistant Master Mechanic will act for him in all matters, effective June 16. H. L. Ingersoll has been appointed Resident Engineer of the Eastern Division, with headquarters at New York City, and W. H. Beck becomes Resident Engineer of the River Division, at Weehawken, N. J., succeeding E. L. Hurley, transferred.

Northern Central.—J. C. Mengel, Master Mechanic at Erie, Pa., of the Pennsylvania, has been appointed Master Mechanic of the N. C., with headquarters at Elmira, N. Y., succeeding Jas. Strode, resigned.

Oregon Short Line.—C. J. McNitt, heretofore Acting Auditor, has been appointed Auditor.

Pocahontas Coal & Coke (Norfolk & Western).—M. J. Caples has been elected Treasurer and Superintendent, succeeding G. L. Estabrook, resigned.

Southern.—E. H. Coapman has been appointed Superintendent of the Danville Division, with headquarters at Greensboro, N. C., succeeding N. J. O'Brien, resigned, effective June 16.

Southern Pacific.—C. J. Wilder has been appointed Assistant Auditor. D. W. Horsburgh succeeds Mr. Wilder as Freight Auditor, and H. S. Lincoln becomes Assistant Freight Auditor.

The headquarters of H. J. Small, Superintendent of Motive Power, will be removed from Sacramento, Cal., to San Francisco.

Spokane Falls & Northern.—L. W. Hill has been elected President.

Union Pacific.—W. R. McKeen, Jr., heretofore Master Mechanic at Cheyenne, Wyo., has been appointed Superintendent of Motive Power and Machinery, with headquarters at Omaha, Neb., succeeding S. Higgins.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

BIRMINGHAM, SELMA & NEW ORLEANS (LOUISVILLE & NASHVILLE).—Work is reported resumed on the branch from Linden to Myrtlewood, Ala., about eight miles. Work was completed as far as Linden last April and then stopped. The extension will not at present be built beyond Myrtlewood on account of the scarcity of rails. (April 25, p. 315.)

CALIFORNIA NORTHWESTERN.—The extension from Ukiah, Cal., about 60 miles northwest along the coast to Christine in Mendocino County, has now been completed to Willits, 26 miles.

CAPE GIRARDEAU & CHESTER.—This company was chartered in Missouri June 5 to build a railroad from a point at or near Cape Girardeau, to a point in Perry County, opposite the city of Chester, Ill., a distance of 60 miles. The incorporators are John A. Hawkins, Thomas A. Proctor, F. F. Lincoln and others, of Cape Girardeau.

CHICAGO, MILWAUKEE & ST. PAUL.—Surveys into Montana are reported with a view to securing an independent line. It is stated in press reports that several hundred miles of road will be built within the next year.

CHICAGO, ROCK ISLAND & PACIFIC.—Surveys are reported for a line running southwest from Rolla, Mo., to the Arkansas line, and surveys in connection with this have been made between Belle and Rolla. It is said that the company intends to build to Little Rock since its purchase of the St. Louis, Kansas City & Colorado.

CHOCTAW, OKLAHOMA & GULF.—The following extensions are now reported completed: Main line from Sayre, Okla. T., west to Texola, Okla. T., 22 miles; Tecumseh branch from Tecumseh, Ind. T., south to Romulus, Ind. T., 10 miles; Ardmore branch from Ardmore Junction, Ind. T., south to Tishomingo, Ind. T., 84 miles; Malvern branch from Butterfield, Ark., to Malvern, Ark., five miles. (Construction Supplement, March 14, 1902.)

CINCINNATI SOUTHERN.—It is said that new yards are to be built at Chattanooga, Tenn., at an estimated cost of $100,000, to occupy 12 acres.

DENVER, ENID & GULF.—Contract was let June 5 to the Bes Line Construction Co., to build this road from Enid, Okla. T., to Marshall, 31 miles. A large force is to be put on and it is thought that trains will be in operation between Enid and Marshall early in August. The right of way is now secured from Enid to a point about 10 miles southeast of Marshall, and from there two surveys have been made, one to Guthrie and the other to Oklahoma City. It is not yet determined which will be built.

EAU CLAIRE, CHIPPEWA FALLS & NORTHEASTERN.—Contract has been let to Winston Bros., of Minneapolis, for 28 miles of a branch of the Chicago, St. Paul, Minneapolis & Omaha running northeast from Chippewa Falls to Little Rock Falls dam, and from that point east to a point near Medford, Wis. This branch was incorporated in Wisconsin last January. It is said that the work is already sublet.

ERIE.—It is said that a large sum will be spent within the next year on betterments of the line, including a considerable amount of double-tracking, new yards, straightening of curves and the replacing of wooden bridges with steel structures. Details of the plan are not yet obtainable, but it is estimated that the cost of putting the line in first-class condition would not be much under $20,000,000.

EVANSVILLE & TERRE HAUTE.—Announcement is made of an extension to be built in Sullivan County, Ind., from the present line to Jasonville, five miles distant. Bids will be received in a couple of weeks.

GREAT CENTRAL.—We are officially informed that work will at once begin on a road designed to connect Coos Bay and Roseburg, Ore., a distance of 45 miles. L. D. Kinney is Chief Engineer.

GREAT NORTHERN.—In regard to current press statements that an extension will be built from Republic to Wenatchee, Wash., 205 miles, an officer writes that there is no likelihood that such a line will be built this summer. A number of surveys have, however, been made.

Surveys are reported in Idaho for a narrow gage line about 20 miles long from Porthill to mining property of the Idaho-Continental Mining Co. near the International boundary. It is said that work will begin this summer.

GULF & INTERSTATE.—In regard to rumors that preparations were being made to rebuild this road in Texas between White's Ranch and Bolivar Point, an officer writes that nothing definite has yet been decided. The road may possibly be rebuilt under reorganization, but will not be with the present receiver. About 30 miles of track were destroyed by the storm in Texas in 1901. Joseph P. O'Donnell, of Galveston, Receiver.

GUYANDOTTE VALLEY.—Contract for the new line to be built in West Virginia between Midkiff and Crawley's Creek, about 35 miles, have been let to Carpenter & Wright, of Huntington, W. Va. J. L. Caldwell, Huntington, is President of the railroad.

HURON & WESTERN.—An officer writes in regard to this line, recently incorporated to build a line 12 miles long in Michigan, that the line will begin at West Bay City and run to coal mines in Bay County. The work will be easy, the line being straight, without bridges or tunnels, and it is expected that contracts will be let soon. Bids will also soon be asked for rails and rolling stock.

Thomas L. Handy, Bay City, Mich., is President. (June 6, p. 422.)

ILLINOIS CENTRAL.—Contract has been let to Roach Bros. for an extension of the Yazoo & Mississippi Valley from Belzona to Yazoo City, Miss., 25 miles. Work is to begin at once under the direction of Captain Sharp. The new line will provide a direct route between Yazoo City and Memphis, by way of Lake Cormorant. Subscription was previously taken up in the towns along the route for this extension, and $25,000 was raised at Yazoo City.

INDIANA HARBOR (ELECTRIC).—Grading is reported under way on this new line which was incorporated last November to build from Indiana Harbor east to Chicago and Lake Michigan to a junction with the Joliet & Northern Indiana R. R. running to Hartsdale, Ind., about 12 miles. Grading is being done by F. L. Hartigan, of Indiana Harbor. When completed the line will be operated by electricity. C. W. Hotchkiss, of Indiana Harbor, Ind., is President. (Construction Supplement, March 14, 1902.)

INDIANAPOLIS, BLOOMINGTON & BEDFORD STONE.—This company has been incorporated in Indiana to build from Bloomington through Victor to Switz City, Ind., a distance of about 40 miles. Joseph D. Oliver, of South Bend, is interested.

JONESBORO, LAKE CITY & EASTERN.—It is said that contracts for 15 miles of new line in Arkansas, near Jonesboro, are ready to be let. The engineer in charge is M. E. Brooks, Jonesboro, Ark.

KENTUCKY NORTHERN.—An officer writes in regard to this projected line to be built north from the Louisville & Atlantic to the Lexington & Eastern, about 15 miles, that it is intended to open up coal and lumber lands. It is not stated when contract will be let. Theo. D. Buhl, of Detroit, Mich., is President, and Wm. V. Moore, Secretary and Treasurer. (June 6, p. 422.)

LAKE HANCOCK & CLAREMONT.—This company is reported incorporated in Florida to build from Lake Hancock through Polk and Lake Counties to Claremont, which is about 55 miles distant. W. J. Carter, of Carters, Fla., is interested.

LAONA & NORTHERN.—This company filed articles of incorporation in Wisconsin June 5. It is proposed to build in a northerly direction from Laona to a point on the St. Paul, Minneapolis & Sault Ste. Marie in Forest County, Wis. The road will be eight miles long lying wholly within the county. W. D. Connor, of Marshfield, Wis., is the principal shareholder.

LEXINGTON & COLUMBIA (ELECTRIC).—This company has applied for a charter in South Carolina to build an electric road between the points named, a distance of about 14 miles. Alfred J. Fox and others, of Lexington, S. C., are interested.

MASSILLON, DALTON & WOOSTER ELECTRIC.—Franchise has been granted this company to use the highway for an electric railroad from Massillon, Ohio, to Wooster and to Dalton, a total distance of about 25 miles. The franchise lasts for 25 years and provides that building must begin on or before Oct. 1, 1902, and that the road must be in operation a year from that date. After 10 years the company must pay the county $25 per year for each mile operated. T. Harvey Smith, County Treasurer, is President.

MEXICAN INTERNATIONAL.—Work is reported completed on the extension between Santiago and Tapasquiaro, north as far as Tepehuanes, 33 miles. This is a portion of the proposed line between Santiago, Tapasquiaro and Guanecevi, 85 miles, building by M. T. Robertson, of Durango.

MOBERLY (ELECTRIC).—This company has been chartered in Missouri to build an electric line from Huntsville to Moberly and Perry, a distance of about 50 miles. J. H. Starr, of Centralia, Mo., is reported interested.

MORENCI SOUTHERN.—This new line in Arizona is now reported open between Morenci and Guthrie, 18 miles.

NEW ORLEANS & SOUTHWESTERN.—Contract for this proposed line from Hahnville, on the Mississippi River, to Montague, La., 77 miles, is reported let to Bryan, Haynes & Turner, of Memphis, Tenn. C. R. Young is General Manager.

NEW YORK, NEW HAVEN & HARTFORD.—Contract was let June 11 to C. W. Blakeslee & Sons for grading and bridge work in Fall River, Mass. It is proposed to remove all the grade crossings in Fall River. The work will be under the supervision of Clarence Blakeslee. (May 2, p. 336.)

NORTHERN PACIFIC.—A large sum of money is now being spent on betterment of the line in Oregon. It is said that $780,000 will be spent on the Pacific Division, which runs from Portland to Ellensburg, and includes the Seattle branch. Twelve miles of new rails will be laid. A large mileage of new sidings and ballasting and general track improvements will also be carried on. A majority of the work will be done east of the Cascade Mountains. Work on the Hoquiam extension is reported proceeding rapidly. The line will be 17 miles and the first 10 miles are now completed. Surveys are also being made between Edgecombe and Everett, Wash., by which it is said the present line will be shortened over 20 miles, if the new route is followed.

PENNSYLVANIA.—Franchise was granted this company June 16 by the Board of Rapid Transit Commissioners to build a double-track railroad from the boundary between New York and New Jersey, under the Hudson River, opposite the west end of Thirty-first street, Manhattan, running thence under the Hudson River and Thirty-first street to the East River, and under the East River to the Borough of Queens. A similar privilege was granted for a double-track line to begin at about the same point under the Hudson and run under Thirty-second street to the East River, and under that river to Queens, with a right for two additional tracks on Thirty-second street beyond Ninth avenue, and one additional track between Fifth and Seventh avenues. Franchise was also granted for a line of two tracks from the terminal station at Thirty-third street and Seventh avenue, to run under Thirty-third street and the East River to a terminal in Queens, with right for an additional track on Thirty-third street between Fifth and Seventh avenues. The rental to be paid has been agreed upon by the city and the company, and taking a total of river rights, tunnel rights for 44,341 ft. in Manhattan and 8,100 ft. in Queens, for street rights on Thirty-first and Thirty-third streets, for a secondary station at Thirty-third street and Fourth avenue, and for a portion of Thirty-second street, $75,535 will be paid annually for the first 10 years, and after that $114,871 will be paid annually for the next 15 years. The franchise may be readjusted at the end of 25 years. The corporate name of the new tunnel under the Hudson River, incorporated at Trenton February 13, is the Pennsylvania, New Jersey & New York, and the corporate name of the tunnel to connect the Pennsylvania and Long Island roads is the Pennsylvania, New York & Long Island.

PITTSBURGH WEST SIDE BELT.—Contract for an eight-mile extension of this line from Bruce to Clairton, Pa., was let June 4 to Ferguson & Co., contractors. The line at present runs out from the Ohio River in the west end of Pittsburgh, and the new portion of the road will include one tunnel, although this will be obviated, if possible. The estimated cost of the work is about $300,000.

QUEEN ANNE'S.—The extension from Queenstown, Md., southwest to Kent Island at the mouth of the Chester River, where new wharves and stations will be built, has been completed. The distance is 13 miles.

RAMAPO TRACTION.—Rights of way are reported being secured for an electric line to run parallel to the Erie from Paterson, N. J., to Ridgewood, Hohokus, Ramseys, Waldwick, Allendale and Suffern, and thence across to New City and along the Piermont branch of the Erie to Piermont; thence to a point opposite Yonkers, where it is proposed to cross the Hudson by ferry. The length of the line will be 62½ miles.

RONCEVERTE, LEWISBURG & WESTERN.—This company has been chartered in West Virginia to build a steam railroad between the points named, a distance of about six miles. The following are interested: D. C. T. Davis, Jr., Alexander F. Matthews and W. E. Nelson, of Lewisburg, W. Va., and W. G. Matthews, of Charleston, W. Va.

ST. LOUIS & NEWPORT NEWS.—This company has been incorporated in Illinois to build from East St. Louis to Newport News, Va. From East St. Louis it is proposed to build through the Counties of St. Clair, Madison, Monroe, Washington, Randolph, Perry, Franklin, Williamson, Saline, Polk and Hardin in Illinois. From some point in Hardin or in Polk County a crossing will be made over the Ohio River into Kentucky, where a connection is to be made at or near Paducah with the Newport News & Mississippi River Valley R. R. The incorporators and directors are Thomas N. Chase, Clarence D. Warner and James A. Reardon, of St. Louis; John L. Brinkerhof, of Springfield, Ill., and others.

SOUTH BEND & SOUTHERN MICHIGAN (ELECTRIC).—An officer of the Indiana Ry. Co., which operates the street railroads in South Bend, Mishawaka, Elkhart & Goshen, Ind., with connecting lines, a total of about 50 miles, will build to St. Joseph, Mich., by way of Niles, under the above. The line will be built at once as far as Niles and contracts will be let at once for grading and small culverts, and proposals taken later on for the bridges. Alonzo J. Hammond, of South Bend, Ind., is Chief Engineer. The distance to St. Joseph is about 33 miles.

TENNESSEE CENTRAL.—Surveys are reported completed for the line between Gracey and Eddyville, Ky., 61 miles, and they have been begun between Clarksville and Hopkinsville, Ky. It is said that building on the line between Clarksville and Nashville will begin within a week and the line is now being staked out.

TEXAS & NEW ORLEANS.—It is said that an extension eight miles long will be built from Sour Lake, Texas, to Sour Lake Springs. The line may also include Saratoga, which is northeast of Sour Lake.

TEXAS CENTRAL.—Announcement is made that surveys for over 300 miles of proposed extensions are now being made. These involve a new line from the present northern terminus at Stamford, to Quanah, Texas, where a connection will be made with the Fort Worth & Denver City; also southeast to Waco and the port of Sabine Pass on the Gulf of Mexico, by way of the Beaumont oil fields. The distance between Stamford and Quanah is about 100 miles, and between Waco and Sabine Pass by the proposed route, about 200 miles.

TEXAS ROADS.—It is said that a railroad to reach timber lands from a connection with the St. Louis Southwestern, will be built in Cherokee County, Texas, near the town of Forrest, where there is a sawmill.

TOPEKA, LAWRENCE & KANSAS CITY ELECTRIC.—It is said that the Gulf, Oklahoma & Kansas Short Line, which was incorporated last July to build in Texas and Kansas, now wishes to let contracts for an electric road with the above title, to be 75 miles long between the points named. W. O. McIntosh, Lawrence, Kan., may be addressed.

TRI-STATE TERMINAL.—Surveys are reported for this new line, incorporated to run from Huntington, W. Va., along the Ohio River to Ashland, Ky., and thence across the river to Ironton, Ohio. As the same parties are interested in both companies, it may be assumed that this is the Kentucky incorporation of the West Virginia & Kentucky R. R., which see.

WABASH.—Contract for five miles more of the line between Mt. Jewett and Mingo Junction, Ohio, was let June 4, to Ferguson & Co., contractors. The work includes sections 50 to 54. Considerable grading is necessary and at least one tunnel will be required. The estimated cost of the work is $400,000.

WASHBURN & NORTHWESTERN.—It is said that a road with the above name is projected from Washburn, Wis., to Pine Lake and Boynton, Wis., about 50 miles. Surveys have been made in charge of H. H. Marsden, Washburn, Wis.

WASHINGTON, BALTIMORE & ANNAPOLIS (ELECTRIC).—Contract for grading this proposed line between the points named is reported let to Rogers & Walker, of Baltimore.

WASHINGTON, NORFOLK & SEABOARD.—It is said that 40 miles of this proposed line are now building. It was incorporated in February, 1899, and contract was reported let to Kearns & Egan in our issue of April 12, 1901. The route then outlined began at Washington and ran south 80 miles by way of Brandywine, Md., and Mechanicsburg to Point Lookout, with two short branches. A. B. Linderman, Lippincott Building, Philadelphia, is President.

WASHINGTON ROADS.—It is said that farmers living between Washtucna and Ritzville, Wash., will build a railroad from a point 15 miles southwest of Sprague, running down the Rattlesnake Flats and through Franklin County to Pasco, a distance of about 90 miles direct. The proposed route lies about midway between the Northern Pacific and the Oregon Railroad & Navigation Co. lines. Dr. Mills, of Ritzville, is interested.

WASIOTO, CUMBERLAND RIVER & BLACK MOUNTAIN.—This company filed articles of incorporation in Kentucky June 10 to build a railroad from a point at or near Mill Rice, on the Louisville & Nashville in Bell County, Ky., up Cumberland River to Hance's Creek, and along that stream and Pitman's Creek to the head of Pitman's Creek, eight miles in Bell County. T. J. Roberts and A. J. Asher, of Wasioto, Ky., and others are interested.

WESTERN ILLINOIS.—Most recent advices about this company reported in our issue of March 28th as incorporated to build from Dahinda, Knox County, Ill., through the Counties of Knox, Stark, Marshall and Putnam, indicate that surveys have been made for 30 miles, and that the first 10 miles from Dahinda to Etherly have been graded. It is now proposed that the other terminus shall be McNab, Ill., 80 miles from Dahinda. Contracts for more grading will be let shortly. W. C. Calkins, of Galesburg, Ill., is President.

WESTERN MARYLAND.—Statement is reported made by a member of the Fuller syndicate that this road will be extended from Cherry Run, W. Va., to Cumberland, to connect with the West Virginia Central & Pittsburgh, but that it will not be extended from Shippensburg, Pa., to Pittsburgh, as rumored. The new line will probably be built along the Maryland side of the Potomac River and will be about 63 miles long.

WEST VIRGINIA & KENTUCKY.—Charter was issued June 12 in West Virginia for a railroad from Sutton, Braxton County, W. Va., to Ironton, Ohio, passing through 13 counties in West Virginia, four in Kentucky and one in Ohio. The total distance is over 125 miles. The incorporators are Homer J. Beaudet, David Levy and Chas. H. Becker, of New York, and W. C. Merritt and W. R. Thompson, of Huntington, W. Va.

GENERAL RAILROAD NEWS.

ATLANTIC COAST LINE.—An officer writes that the official taking over of the Plant System by the Atlantic Coast Line will occur July 1.

CHICAGO, ROCK ISLAND & PACIFIC.—Holders of outstanding capital stock of the Burlington, Cedar Rapids & Northern, recently absorbed by lease, are offered the privilege of exchanging it, share for share, for stock of the Chicago, Rock Island & Pacific. Additional consolidated first mortgage and collateral trust 5 per cent. bonds of 1934 have been listed to the extent of $553,000, making a total of $7,803,000. Cedar Rapids, Iowa Falls & Northwestern bonds, issued under mortgage of 1884 and covering the new line from Lake Park to Worthington and Hardwick, Minn., have been deposited with the mortgage trustee to the extent of $553,000. (June 13, p. 454.)

HAVANA ELECTRIC.—Edward Sweet & Co., of New York, offer for subscription $7,500,000 5 per cent. consolidated mortgage 50-year gold bonds, being part of an authorized total issue of $10,000,000, the remaining $2,500,000 to be left in the treasury for future capital expenditure. The Central Trust Co. of New York is trustee. The bonds are issued partly to take up $5,000,000 first mortgage bonds, $768,000 second mortgage bonds, and $582,000 coupon notes, etc., of the Havana Electric Co., outstanding. Practically all of these, with the exception of about 20 per cent. of first mortgage bonds, have agreed to exchange the same for the consolidated bonds. Edward Sweet & Co. are authorized to receive applications for the above-described consolidated mortgage bonds at $980 for each $1,000 bond. The right is reserved to reject any application and to award a smaller amount than applied for.

INDIANAPOLIS NORTHERN TRACTION.—This company, reported in our issue of April 25 as incorporated to serve as a consolidation of a number of electric interests in various cities north of Indianapolis, Ind., and to build from Indianapolis to Logansport, with a number of other lines, has purchased the franchise of the line to run from Kokomo to Logansport, 25 miles, and has acquired by merger the Logansport, Rochester & Northern Traction Co. The last has franchises for a line from Logansport to Kendallville, Ind., by a route 101 miles long, with 20 miles of branches. Arrangements for other mergers in the locality are reported. The directors of the Indianapolis Northern Traction Co. are Chas. A. Baldwin, Henry Moore and others.

METROPOLITAN STREET (NEW YORK).—Announcement is made that Kuhn, Loeb & Co. have purchased $12,400,000 of the $65,000,000 new 4 per cent. bonds. Improvements call for $11,000,000 of this issue, the remainder of the bonds being issued for refunding purposes, and Kuhn, Loeb & Co. have taken over all the improvement bonds.

PHILADELPHIA & READING.—The lease of the Reading Belt line to the above was placed on record, June 14. The Philadelphia & Reading pays as rent 4 per cent. interest on the $750,000 Belt Line bonds outstanding, besides taxes and repairs. It must also make good any deficit in case the revenues of the Belt Line from assets not included in the lease are not sufficient to pay the requisition expenses to maintain corporate existence.

SMYRNA & DELAWARE BAY (PHILADELPHIA, WILMINGTON & BALTIMORE).—This road, which extends from Bombay Hook Island in Delaware Bay, into Maryland, and is a part of the Philadelphia, Wilmington & Baltimore system, was seized on June 12 by the sheriff of Kent County, Del., and will be sold on July 5 at Smyrna. The reason for this action is said to be that the Pennsylvania desires to secure clear title, and that it is at present somewhat involved.

TOLEDO RAILWAYS & LIGHT.—This company, which has a capital stock of $12,000,000, is now under control of interests represented by Kean, Van Cortlandt & Co., of New York. It was, a short time ago, a portion of the Everett-Moore Syndicate, and the last-named loses an important link in its combination by the present transfer of interest. The Toledo Railways & Light Co. controls the street railroads and electric lights of Toledo, Ohio, having been organized in July, 1901, and after that having taken over the franchises of the two existing companies in the same field. It operates 102 miles of track and has a bonded debt of $12,000,000, of which $4,000,000 is outstanding, $6,000,000 reserved to take up bonds of component companies, and $2,000,000 for betterments. It is said that the Everett-Moore Syndicate still retains a small interest in the property.

VENANGO POWER & TRACTION.—This company, which is a consolidation of all the electric railroads in Venango County, Pa., with a total mileage of 32, and which serves a population of 30,000 and has other extensions building which will reach a population of 17,000 additional, offers through F. T. Harrington, of New York, $660,000 of an issue of $1,000,000 first lien 30-year 5 per cent. bonds, dated last July and redeemable at any interest period before 1911 at 115 and interest, and thereafter at 105 and interest. The price offered by Harrington & Co. is 103½. This issue comprises the total bonded debt of the company and there is $1,000,000 capital stock outstanding.

WESTERN MARYLAND.—On June 16 the Fuller Syndicate completed the acquisition of a majority of this company's stock by paying to the Washington County Commissioners $324,000 for preferred stock, and $110,000 for common stock. After settlement for the 4,000 shares owned by the city of Baltimore is made, the city directors will retire and it is generally understood that the Western Maryland will be merged under the same management with the West Virginia Central & Pittsburgh as an eastern extension of the Gould Lines.